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VOLUNTARY MOVEMENT

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This paper aims to describe the cognitive aspect of the psychic experience in voluntary movement. It is therefore limited in two respects: first, to the sensory and ideational processes without attempting a detailed account of the feeling processes in such movements; second, it is limited to controlled *movement* and does not attempt an account of what may be called 'inner volition.' More specifically it is limited to the following four lines of discussion.

First. It aims to summarize critically the experimental and more important studies of voluntary movement, particularly such studies as bear upon the problem of the function of the "resident" and "remote" processes.

Second. To describe certain experiments undertaken for the purpose of a fuller description of the cognitive processes involved in voluntary movement and especially for the purpose of describing the gradual automatization of a highly volitional series of acts.

Third. To point out the bearing of certain anatomical, physiological and pathological data upon the rôle of (first) the centripetal impulse and (second) the sensation in voluntary movement.

Fourth. To point out the bearing of all these data upon the general theory of voluntary movement.

I. Literary Orientation

A cursory examination of current psychological text-books and literature reveals fundamental differences of opinion with reference to the universality of the image in mental processes.

Quotations from the following authors will suffice to justify this statement. In his recent text-book (p. 210) Angell writes: "The content of our thought is, so far at least as concerns the knowledge process, always made up of imagery." This position may perhaps be taken as the generally accepted view. Some writers, however, like Dewey hold that "every mental state is as *an existence*, an image." (Psychology, p. 204.) While not expressly stating such a view, Titchener at least implies in his Outlines of Psychology that an image peripherally or centrally aroused conditions every state of consciousness. Opposed to this view there is a small but vigorous group of writers whose position is well represented by Stout, Woodworth and Bühler. Stout argues, in his Analytic Psychology (Vol. I, p. 80), that imagery does not accompany the use of words in ordinary discourse. His reasons are that inasmuch as introspection fails to detect such images there should be "strong positive ground for assuming their presence." In the Bericht über den II Kongress für experimentelle Psychologie (p. 264), Bühler states his position thus: "Welches sind die Bestandstücke der Verschriebenen Denkerlebnisse? Antwort: Vorstellungen aller Art, aller Sinnesgebiete, Sach- und Wortvorstellungen, aber ausser ihnen viel häufiger, reicher und mannigfaltiger andere Gebilde, die am häufigsten als Gedanken, oder in Anlehnung an Marbe und Ach, als Bewusstseinslagen oder Ueberzeugung bezeichnet wurden. Es zeigt sich, dass man Vorstellungen und Gedanken im allgemeinen ganz sicher auseinander zu halten vermag."

After quoting from his own introspections and from those of others under experimental conditions, reporting an absence of imagery, Woodworth goes on to say (*J. Phil., Psy. and Sc. Meth.*, Vol. 3, p. 705) that it is necessary to assume the existence of conscious elements not reducible to sensory terms and that these elements must be looked upon not as "syntheses of sensory qualities, but simply and purely the qualities of particular thoughts."

It will be seen from the above that with reference to the existence of the image in the various mental processes psychologists are divided into at least three camps. (1) A group of writers holding that absolutely every state of consciousness implies the presence of imagery; (2) Another group insisting that at least all *cognitive* processes demand the presence of sensory imagery; (3) A group boldly declaring that even the cognitive processes are or may be carried on without the presence of a sensory or ideational image for every thought item in the process.

What now is the status of opinion when one narrows the field of inquiry to the mental processes that condition voluntary

movement? Here too there are 'camps' though the vagueness in the use of the term 'voluntary,' coupled with its peculiar individual uses and the various interpretations of the current kinæsthetic theory of voluntary movement, make it much more difficult, if not practically impossible, to classify the different positions found in the literature upon the subject. James' exposition (Prin. of Psy. Vol. II, pp. 486-592) of the kinæsthetic theory reveals, as Woodworth has pointed out, the possibility of a wider and a narrower interpretation of this theory. The theory is so familiar that a summary of it seems unnecessary.

The latitude of interpretation which James' statement permits reflects what one actually finds in both earlier and later writers, namely, in some cases, a limiting of the mental antecedents necessary to a voluntary movement to "resident" processes with the possible inclusion of remote visual effects. Ziehen (Intro. to the Study of Phys. Psy., pp. 246-248) and McDougall (Phys. Psy., pp. 163-165) are clearly inclined to this narrower view. On the other hand Münsterberg (Willenshandlung, pp. 88-96) and Angell (Psy., pp. 404-409) give the theory a broader interpretation so as to accord a fuller recognition to James' "very remote" sensible effects.

One of the earliest criticisms, based upon experimentation and observation, of this entire position is found in an article by Kirkpatrick (The Development of Voluntary Movement, *Psy. Rev.*, Vol. 6, 1899, pp. 273-281) in which he reports a study of the motor development of one of his own children. His observations lead him to the conclusion that "there is no evidence that his (the child's) consciousness is concerned at all with the movements he is making in order to get hold of the object and bring it to him,—attention to the movement itself hinders rather than helps in learning the movement." (p. 280.)

Another investigation having an important bearing upon this problem is Bair's study of how we get voluntary control of an entirely unused muscle, the *retrahens aurem* by means of which the ear is moved. (Development of Voluntary Control, *Psy. Rev.*, Vol. 8, 1901, pp. 474-510.) Twelve of the fourteen persons who acted as his subjects had absolutely no control of the ear at the beginning of experimentation. In order to give his subjects the kinæsthetic sensations and images produced by the movement of this muscle, Bair at first caused the muscle to contract by means of electrical stimulation.

His results may be stated both negatively and positively. Negatively he found that the kinæsthetic sensation or image of the movement of this muscle was not in itself sufficient to bring about voluntary control. Positively, he found that before control of a muscle is established the sensation produced by the

reflex or involuntary movement of that muscle must be experienced in association with the sensations from the near-by muscles over which voluntary control has already been gained. He says: "The contraction could not be made voluntarily, not even after it was repeated (artificially of course) a sufficient number of times thoroughly to impress the sensations and definitely to fix the association between the muscle sensation and the visual impression of it." (pp. 499-500.) This appears to imply, that both "resident" and "remote" (visual) sensation were given the reagent without his being able to make the movement voluntarily.

Bair explains that getting control of such a muscle means three things: (1) Producing the movement accidentally through the spread of excessive energy into outlying muscles not yet under voluntary control thus giving a new muscle sensation, or sensation from a muscle from which sensations have not hitherto been experienced. (2) It means the association of this "new" sensation with sensations from muscles already under control. (3) The dissociation of this sensation from the complex of sensations in which it originally arose, so as to be caught separately by attention.

If one distinguishes between sensation and image, a distinction which certainly is not one merely of words, then the findings of Bair's study do not lend unqualified support to the kinæsthetic interpretation of voluntary movement, which explains the whole process in terms of memories or images, "resident" or "remote," of movements which took place involuntarily, or at least non-voluntarily. Bair shows that the memory, or image, of how it feels or looks to have the ear moved is not sufficient to bring about its voluntary movement.

A third experimental study with important bearings upon this question is Woodworth's investigation of "The Cause of a Voluntary Movement." (Studies in Philosophy and Psychology, Garman Memorial Volume, pp. 351-392.) Woodworth's subjects were required to make various movements, some of which, as Angell points out, were probably "too well mastered and too habitual to throw fairly into the foreground the sensory-ideational elements emphasized in gaining control of them." ("Studies in Psy., *Journal of Phil., Psy.*, and *Sci. Methods*, Vol. 3. p. 241.) It is, however, to be noticed that Angell's use of the term "sensory-ideational" implies a failure to distinguish between sensation and image, a distinction of which Woodworth makes use and which has important bearings upon the whole problem.

Out of 128 single introspections Woodworth summarizes the imagery as follows: 27 reported kinæsthetic, 27 reported

visual, 17 reported imagery of other kinds, 30 reported only peripheral sensations, 27 reported an absence from the field of attention of all sensory or ideational imagery. (p. 361.)

Woodworth states that in many of the instances in which imagery was reported, there was what he and Bühler call an "inadequacy" of imagery. This was particularly true of kinæsthetic images which, when present, were found to be unlike the movement that followed. "Sometimes the kinæsthetic represented movement was much briefer than the real movement. Sometimes the kinæsthetic image pictures a slow movement when the resulting movement is rapid. In general this sort of image frequently contrasts with the resulting sensations of actual movement. If we picture how a movement is going to feel and then make the movement we find it feels very different from what we anticipated." (pp. 362-363.)

This illustrates what these authors mean by the "inadequacy" of images. Bühler goes so far as to argue that the "Inadäquatheit zwischen dem Gedankengehalt und dem, was vorgestellt wird" (Kongress für experimentelle Psychologie, Bericht II, 1906, p. 264) is an indirect evidence that thought processes are carried on without imagery. Doubtless he would hold too, with Woodworth, that voluntary action may take place at the instigation of a "naked," imageless, thought.

This concept of the adequacy or inadequacy of mental imagery appears to be borrowed from the physical sciences and transferred bodily to the field of psychology. The argument seems to run thus: If a kinæsthetic image is *the* cause of a voluntary movement, then as such it must contain as much as is contained in the result, just as in physics the cause must, in terms of energy, be equivalent to the effect. Against this position the following arguments may be urged:

(1) The concept of "Adequacy" in the sense that, to be the cause of a movement, the mental image must contain as much as will be contained in the movement, reduces itself, when logically carried out, to a *reductio ad absurdum*. Bühler applies this concept to the thinking process, as has been shown, and concludes that images are not necessary to complex thinking processes because the image is frequently "inadequate." But why stop with movement and thinking? Why should not the same argument be applied to all mental processes and finding that everywhere images are "inadequate," as they certainly are, in the sense in which these authors seem to use the term, conclude that images are not essential to any of our mental processes, and thus rule the image out entirely and regard it as a really useless thing in all forms of experience?

(2) It is not always true that "the adequacy or inadequacy of images is a point of importance in judging how much of a real causal function the image has in the production of movement." (p. 362.) Many things come in to modify this "importance" of the adequacy or inadequacy. Reflexes, instincts, habits and "psycho-motor" tendencies all come in to supplement any lack that may exist on the part of the initial image. And, what is still more to the point, the immediately inflowing sensations, once a movement is started, are of incalculable service in the further control of it. Woodworth himself has pointed out that the coördinations of a movement are unconscious processes. The details, therefore, of a movement need not be included in the image in order that it be adequate.

(3) This idea is not a psychological concept. It is rather a logical, *a priori* idea, and as such practically the same argument may be urged against it that Woodworth presents in opposition to the image theory, namely, that it is too "schematic." As a sort of logical necessity it is apparently *assumed* that *to be adequate* the image *must* contain what will be contained in the forthcoming movement, and *then*, when introspection reveals that the image does not contain qualitatively and quantitatively what the movement sensations reveal, it is *therefore* declared "inadequate."

Woodworth refers also to his own attempt to learn to move the great toe in isolation from the others. "The establishment of complete voluntary control is a very gradual process." (p. 36.) He finds, too, with Bair, that the first success comes by accident. Gain in control is then made by directing attention to the member itself. In this, too, he agrees essentially with Bair who found that the final stage in getting control of a muscle consists, as has been stated, in dissociating the sensation of the movement of the muscles in question from the sensations derived from other and already controlled muscles. But while the kinæsthetic *image*, and in fact imagery of every sort, is entirely unnecessary, Woodworth holds, that kinæsthetic *sensations* from a member are indispensable, maintaining that "sensations are indeed always present, as contributing factors in determining the act. They represent the existing situation with reference to which the act is performed, and the act is determined by the existing situation as well as by the intention." (p. 383.) This position will be referred to again in the discussion of the relation of sensation to movement.

Thorndike calls attention to five facts, which in his judgment argue against the kinæsthetic theory.

(1) The same imagery will frequently be found employed

in willing *not* to do a thing that we find in willing to do it. This fact he regards as a good reason for the suspicion that in willing to do a thing the image of doing it comes as a natural consequence of the idea and *not* "as a necessary dynamic factor in the action."

(2) "We can will acts images of whose resident sensations are not obtainable." This position, he holds, is supported by the fact that we can perform many operations in less time than it takes to call up the imagery. For example, one can write a combined series of figures, letters, dots and dashes in less time than it takes to call up the various resident or remote images representing the various movements. To this, doubtless, the supporters of the image theory would reply that all such movements have been practiced until so completely habitual as no longer to require the presence of the imagery that functioned at the time the movements were learned.

(3) In many of our voluntary acts we will to do things so complex that it would take all of us several minutes to call up the imagery of the series of movements involved. For example, we can will to draw a polyhedron of 28,000 sides.

This objection is apparently based upon the erroneous idea that such a complex act as the example given is a single act. To draw a polyhedron of 28,000 sides is clearly not a single act but a connected series of acts, from both psychological and physiological points of view; and therefore, if it calls for imagery at all, practical necessity would demand a series of images and not a highly complex image before beginning the drawing.

(4) "In trying to get any one to make a voluntary movement we rarely take means specially useful in calling up the images of resident or remote sensations, and often do take means specially to prevent their appearance."

(5) "If we insist on the image's effective presence we make voluntary action sharply discontinuous with involuntary action." (The Mental Antecedents of Voluntary Movements, *Jour. of Phil., Psy., and Sci. Methods*, Vol. 4, 1907. pp. 40-42.)

The experimental study by Ach, Ueber die Willenstätigkeit und das Denken (Göttigen, 1905,) is perhaps the most systematic investigation of this question thus far made. Ach's position, it will be observed, agrees in a measure with the position of Woodworth and Thorndike.

Previous studies of voluntary movement, Ach finds, have for the most part been confined to reaction-times and have, therefore, neglected the psychological processes involved. The analysis of these processes is the author's object. He used simple and complex reactions with the Hipp chronoscope as the recording instrument.

With relation to the content of consciousness present in the various reactions employed Ach expressly states or implies the following observations:

(1) The particular content of consciousness present in a given reaction varies, first with the individual tendencies. ("Individuelle Veranlagung spielt hier eine grosse Rolle.") It varies also with practice and, thirdly, with the apperception of the stimulus.

(2) The mental processes involved in all voluntary action are in no small degree determined by what the author calls "determining tendencies." These tendencies are the results of the presence of an idea of a *goal* or *end* to be accomplished by the reaction. In themselves these tendencies may be entirely unconscious, but they are nevertheless essentially effective in shaping the mental content controlling the reaction.

(3) When the reaction itself takes place there is no discoverable "will" process or content, as such, present. All this comes at an earlier period when the subject consents, as it were, to the procedure as a whole.

(4) Ach and his subjects discover in the content of the volitional consciousness what may be classed as two sorts of sensation, both, however, being *necessarily* present *only* in the early and unlearned stages of the reaction. Both may be entirely absent at the later and familiar stages. The first sort of these sense processes is made up of the usual peripheral sensations set up by the stimulus. The other class, highly important in Ach's account, is essentially kinæsthetic sensations. Ach prefers to call them "intentionalen Bewegungsempfindungen." They are, however, he tells us, "Spannungsempfindungen" and have their origin in the muscles. Their function is to give us the trend or direction ("Richtung") of the forthcoming movement. Ach speaks also of sensations which are mere accompaniments—Begleiterscheinungen—which do not appear to serve any particular function.

(4) Then there are all sorts of memory images, visual, acoustic, kinæsthetic, etc., which present themselves most frequently in the early stages of voluntary action and then disappear more or less. Upon the presence of these images, which constitute the essential elements in the image theory, Ach does not appear to lay much stress.

(5) Finally there is present, particularly after practice and frequently in the period after the ready signal has been given (Vorperiode), a functional mental content—and sometimes it constitutes the entire consciousness of the moment—in which no *imagery at all* is to be found. This consciousness is at times entirely without sensations of any kind; even the highly important "intentionalen Bewegungsempfindungen" are wanting.

"Wir bezeichnen dieses Gegenwartigsein eines unanschaulich gegebenen Wissens als Bewusstheit." (p. 210.) This "Bewusstheit" which is characterized by the "Wissen" that it contains cannot be further analyzed. However, in his discussion of this imageless and sensationless state of consciousness Ach brings out the following facts concerning it: (a) Its constituent parts (*Bestandteile*) fade with repetition. (b) The intensity of the *Bewusstheit* decreases with practice and familiarity. (c) The whole process may be designated as a lessening of concentration of attention.

(6) The further fact is to be noticed that the *Bewusstheit* is *always* immediately preceded or accompanied by sensations (Spannungsempfindungen), visual, acoustic, kinæsthetic, etc., or by a memory image of such sensations. The clear, unequivocal content of the imageless consciousness does not, however, in Ach's judgment warrant describing it in terms of indistinct sensation or memory representations.

(7) It would appear then that this imageless content is not a *derived* consciousness but is, as Woodworth puts it, an original consciousness having a distinct quality of its own.

Another study throwing light upon the problem of the necessary elements functional in voluntary movement is that by Downey. (Controlled Processes in modified Handwriting. *Psy. Rev. Monographs*, Vol. 9, No. 1, pp. 1-148.) Downey studied handwriting under modified conditions, such as elimination of visual control by blind-folding, mirror writing, inverted writing, embarrassment of motor control with and without vision, etc.,—and also under conditions of distraction. The more important results bearing upon this study may be summarized as follows:

(1) Throughout the tests the reagents fell into two groups, one emphasizing visual, the other "grapho-motor" control.

(2) "Individual variation was the extent to which the subject had recourse to grapho-motor control either conscious or automatic." (pp. 51-52.) But "when the break up in the motor coördination was sufficient to demand the acquiring of a new writing reaction the former reagents (grapho-motor group) tended to use consciously more motor material than did the latter (visual group). The form of the break-up usually occasioned intensification of the visual control." (p. 140.)

(3) In the distraction tests the grapho-motor group "showed the strongest tendency to write more or less automatically; the second group the strongest tendency to control writing consciously." (pp. 125-126.)

(4) "Mirror writing increased the tendency to rely on grapho-motor control, a surrender partly to motor automatism but partly also a control by motor anticipation," but "in in-

verted writing . . . there was a gain of visual over motor control." (p. 52.) In the case of one reagent "the visual material represented a pseudo-control, but with the embarrassment of the motor situation it became actually directive." (p. 46.)

(5) A negative result of much importance for a later section of this paper is to the effect that "no evidence was found for the initiation of a *voluntary* act [italics Downey's] of writing without a sensory cue of some sort." (p. 142.)

(6) Another important result is that "throughout the whole series of experiments the *report* coming from the writing in terms either of kinæsthetic or visual sensations and images, proved to have a highly important function as part of the writing cue." (p. 142.) "A sensory kinæsthetic report on the movement as it proceeds is of course usually present, although it varies apparently in vividness and accuracy from individual to individual and has a different value for the same individual under different conditions." (p. 7.) "Many lapses occurred in B's writing of the verse, due, he asserts, to the lapsing or retarding of the grapho-motor report." (p. 63.) "Open errors frequently resulted from the lapsing of the grapho-motor report from the writing and were most often found in reagents of the first (motor) group." (p. 142.)

(7) "When automatic writing occurred, it was apparently, purely physiological in character." (p. 142.)

(8) In contrast to Ach and Woodworth's findings, Downey brings forth no evidence whatever in favor of an imageless consciousness which is at the same time operative in effecting control.

(9) Although "the experiments offer some evidence (which, however, is not 'unambiguous') for the existence of grapho-motor imagery"[1] (p. 142), it is, however, perfectly clear that so far as control is concerned there is no evidence showing that such imagery is necessary.

To turn now to the broader aspect of this subject, it would appear that there are three important psychological concepts that have an indirect bearing upon the problem of voluntary movement. They are: (1) The Reflex arc concept. (2) The concept that *all* consciousness is motor. (3) The concept of motor and sensory forms of reaction.

Dewey has shown (The Reflex Arc in Psychology, *Psy. Rev.*, Vol. 2, 1896, pp. 357-370) that the reflex arc concept should be given a fuller recognition in the study of movement and also in the study of all conscious processes and that once given such a recognition this concept necessitates a readjustment of psy-

[1] *Cf.* Book: The Psy. of Skill, p. 54. Montana University Studies, Vol. I, No. 1.

chological procedure. Our present terminology and analyses, he points out involve an unfortunate dualism, like the dualism of body and soul to which it harks back. We have been accustomed to think of the sensory stimulus as one thing, the central activity, standing for the idea, as another, and the motor discharge, standing for the act proper, as a third. But instead of viewing these elements as each a distinct entity, they should be viewed as "divisions of labor, functioning factors, within the single concrete whole, now designated the reflex arc." (p. 358.) A stimulus always breaks into a coördination and not into a sensation mass. Whenever we turn round upon ourselves what we find is a coördination, an act taking place. Within this act lie both sensation and movement as phases of it.

On the basis of this conception this much may be laid down, namely, that voluntary movement never starts *de novo* and never begins with a mere sensation mass; it always breaks in upon an existing coördination. But when consciousness plays a part in the formation of a new adjustment or rather the modification of an existing one, attention is directed to the sensation phase of the coördination because this phase represents the existing situation with reference to which the adjustment is made. When, now, one asks, precisely what elements of the sensation phase of coördination must attention be directed to, any of it, all of it, or only *certain* elements of it, the position of the image theory at once becomes arbitrary; for, to be consistent, it must hold that *immediate sensations are not* a sufficient basis upon which to make a volitional movement,—there must be present *images* of sensations experienced in involuntary and reflex activity. The objections here raised are that this position is first of all highly arbitrary, and secondly, as Thorndike has pointed out, puts volitional over against involuntary activity so as to make the former radically distinct from the latter. Moreover, whether we regard voluntary movement as an activity developed out of original reflexes, or whether we regard reflexes as the products of conscious impulses and volitional control the relation between them, in either case, is rendered arbitrary if we take the position that in voluntary action *certain* senses and ideational elements are the essentials while in other forms of activity any peripheral or central processes that bear a relation to the situation with reference to which the act is performed are sufficient.

At this point the theoretical exposition of "Consciousness and Movement," by Judd, based upon a variety of experimental studies by himself and his associates in the Yale Laboratory, is significant. Judd calls attention to the distribution of the sensory areas in the cortex. "The sensory centres," he says, "except the centre for touch, are distributed in the

highest brains in such a way as to be relatively isolated from each other and from the motor area. The association areas which link these widely separated sensory centres are clustered in unmistakable fashion around the motor area." (*Psy. Rev. Mon. Supp.* 7, 1905, "Movement and Consciousness," p. 207.) Judd holds that all paths lead to the motor area through the associational tracts; that the higher senses do not "reach the motor areas *through* tactual centres." (p. 209.) He points out that muscular and tactual sensations are unrefined and that "requirement of sensory control and refinement of movement go hand in hand. Why, then, should the conscious processes in which visual factors are fused be continually referred back to a primitive form of sensation for their explanation?" (p. 218.)

The bearing of Judd's contention upon the problem of this paper is evident. All impulses move toward the motor area; sensations do not arouse other sensations but motor responses. The higher and phyletically later sense processes are more "refined" than the older tactile sensations. The later acquisitions, therefore, more accurately represent the situations to which adjustments are made. There is, therefore, no reason why images of these later and more refined sense acquisitions should not, so far as any imagery at all may be concerned, play as original and important a rôle in volitional acts as any other imagery.

In the language of James, "All consciousness is motor," a fact so frequently demonstrated as to be a commonplace. But if the image theory of voluntary action is strictly interpreted some elements of consciousness under volitional conditions require the presence of additional conscious data in order to become effectually motor. To put it in the physiological terms in which Judd has expressed the situation, some sensory impulses cannot pass over into motor impulses without first arousing certain other sensory activities which are the physiological correlates of previous sensory experiences obtained under involuntary conditions. In fine, if the image theory is interpreted in accordance with the scientific usage of psychological terms it involves a serious modification of the proposition that 'all consciousness is motor' in case of all reactions above the level of the involuntary and the habitual. Here once more we are face to face with a break between the voluntary and involuntary which in turn involves a gap in the image theory not yet bridged over by its supporters.

There is a third concept current in the psychology of movement which is apparently difficult to explain on the basis of the image theory. This is the notion of sensory and motor forms of reaction. When the subject is making reactions that

are highly volitional, as has been frequently the case in studies of reaction time, how is it possible to have a sensory type of reaction at all? Suppose, for example, the subject is reacting with his toe or his lips as in the case of Angell and Moore's study. In this case the image theory would demand that before the subject could make his reaction there must appear in consciousness some kind of image of the movement itself. Here, then, it would be misleading to speak of a sensory type of reaction for the reason that the image of the stimulus would have to be followed by an image of the movement either as felt, seen, or experienced in some other form, before the movement could be made. That the intervention of such an image does not necessarily take place, particularly after practice, is pretty well established by Ach and (by implication) by Downey and by experiments to be described later in this paper. This makes the concept of sensory and motor types of reaction correspond to what the names imply and to what has been commonly understood to be the distinction between them.

In interpreting his own theory James has said: "In the chapter on the Will we shall learn that movements themselves are results of images coming before the mind, images sometimes of feelings in the moving part, sometimes of the movements' effects on the eye and ear and sometimes (if the movement be originally reflex or instinctive) of its natural stimulus or exciting cause." (Vol. I, p. 445.) The literature reviewed and the arguments already set forth demand a modification of this position.

It is clear that much of the older literature bearing upon voluntary movement is not only general in character but to a degree at least *a priori* in its derivation, and hence, as Woodworth has pointed out, logical and schematic rather than strictly psychological in its treatment. The weakness of these older studies is therefore primarily methodological but a weakness which in turn brought errors of result and interpretation. Another methodological error that has crept into certain more recent studies of voluntary movement is that of studying thoroughly practiced movements, and from such study drawing inferences with reference to voluntary movement in general. 'To instruct a person verbally to make certain very familiar movements and then from the absence of supplementary imagery to draw the inference that imagery in general is not necessary for voluntary movement' (*cf.* Angell's review of "The Cause of a Voluntary Movement." *Jour. of Phil. Psy. and Sci. Meth.*, Vol. 3, pp. 641 f.), is not only an error of fact, as will be shown later in this discussion, but is primarily an error of procedure which leads directly to the error of fact.

To avoid such errors the study, to be described, is based primarily upon new and unpracticed movements and also upon highly voluntary movements practiced until they became nearly automatic.

II. Description of Experiments

The movements studied were the following:

(1) Writing ten standard words on an apparatus resembling a typewriter until the reactions became practically automatic.

(2) Writing with the hand under novel conditions and also with distraction.

(1) Typewriting experiments.

The problem in these experiments was to describe not only in cross-section the cognitive elements involved in control but also to trace the gradual elimination of these conscious elements up to the point of automatism.[1]

The apparatus used was constructed by fastening ten small rubber bulbs upon a board about sixteen inches long in such a way as to fit comfortably the fingers and thumb of each hand when placed upon the "keyboard." All the bulbs were connected by means of a rubber tube to a single tambour writing upon the drum of a Ludwig kymograph, which was placed on the opposite side of a screen from the subject. The bulbs were "lettered" by means of letters printed upon a cardboard strip and corresponded to the lower row of keys of the Blickensderfer typewriter. From these letters the following list of ten four-letter words was made up: *tons*, *hear*, *tide*, *road*, *hits*, *shin*, *nods*, *dear*, *heat*, *iron*. It will be observed that out of a total of 40 letters each letter occurs four times, thus giving all the fingers equal practice. A graphic record of the writing of these ten words was taken on a kymograph drum at the beginning of each sitting, the writing being to dictation of the words by the conductor of the experiment. This was followed by a brief "practice" period, at the conclusion of which a second record was taken in the same manner. At first the "practice" consisted of ten repetitions of the standard words with the list placed where it could be conveniently seen; but after the list had been memorized the words were written also five times with eyes closed in addition to the ten times with eyes open.

The difference between these movements and those of gen-

[1] The experiments of this section were undertaken before the publication of Book's study above mentioned, and with only indefinite knowledge of his general results. Since then his paper has been read with care and in many ways found to support the main theses of this paper. A review of it has seemed impractical, however, on account of limited space.

eral typewriting consists in the fact that after the subject had once learned the order of the letters on the keyboard and the list of words to be written he knew at each point in the series of movements just what was to be done next. Indeed, in their general nature these movements resemble complex reaction-time experiments involving discrimination and choice, rather than ordinary typewriting, differing from the former only in the fact that the stimuli were given in a uniform order.

The four subjects *C*, *D*, *E* and *R* who served for this experiment were graduate students in the department of psychology of Clark University. Each had had experience as a reagent prior to this experiment. *C*, *D* and *E* gave thirty sittings, each writing the list on the average nearly 500 times. Besides the brief "practice" period mentioned, *R* also wrote the list from ten to twenty times per day for additional practice, thus writing the entire list a total of over a thousand times during a period of seven weeks.

That these movements became practically automatic with daily practice in a few weeks' time is not surprising when the simplicity of each movement taken by itself physiologically is considered. The simplicity of the movement as compared with ordinary writing or throwing a ball, is in itself sufficient to account for the rapidity of automatization. This fact was a decided advantage since it permitted a genetic study as well as a cross-section study which was all the experiments on ordinary writing afforded.

The most striking characteristic of the first stage of control in these type writing movements is the pronounced dependence upon the eye on the part of every subject. This was true not only when writing from the list in "practice" but also when writing to dictation for the records. In this first stage while writing to dictation the subject apperceived the word by pronouncing it in inner speech, then repeated, in inner speech, each letter while running his eyes over the "keyboard" to locate each letter of the word before the writing (*i. e.*, pressing the bulb) was begun. In addition to fixating each letter before the word was begun, it was again attentively fixated when the corresponding bulb was pressed, making a double visual sweep of the cardboard guide which carried the letters. Not only was this true, but in case of the two subjects *C* and *R* who had had no especial practice in controlling the fingers separately, such as is afforded by typewriting or piano-playing, *the attentive fixation was extended from the letters on the cardboard to the corresponding bulbs as each was pressed.* The other two subjects, *E* and *D*, one a practiced piano-player, the other a typewriter, gave no indication of fixating the bulbs during this first period.

This difference, we are inclined to believe is not accidental, but directly due to skill previously gained in the separate control of the fingers, the skill thus acquired showing itself in the ability to write as readily without bringing the point of regard so close to the fingers as was done by the other two subjects. *C* and *R* focussed *every separate objective* item involved in the writing with the exception of the fingers.

While inner speech was distinctly conscious at this stage, there are no reports showing that it became a focal element. It would seem that the inner speech in this case was very much the same as it is in silent reading; attention is upon the page and the meaning and never upon the inner speech as such. Inner speech reacts upon and modifies what is attentively seen (or heard) instead of what is seen (or heard) reacting upon and modifying what is present in inner speech.[1] Indeed the latter would involve a complete reversal of the situation as it is given to the subject, for the reason that what he starts with is, in practice, a fixated word, and in dictation a heard word. Meaning always implies the associative play of another process upon the one that *has* the meaning. It is clear that a sense process cannot possess *conscious* meaning in and of itself; it must call up something, be reacted upon by something, to have meaning. In this case the visual sensations flowing in from the list of words or the auditory sensations flowing in by virtue of the dictation, are reacted upon by inner speech and thus get their meaning. In this sense the "inwardly spelled word" is the immediate cue for the consequent movements, *although the entire cue is always the total situation as perceptually cognized by focal and marginal processes.* Inner speech was at first more or less strongly muscular on account of the effortful nature of the whole performance. Another characteristic of this first stage of the movements under discussion is that the muscular sensations, though clearly conscious, are never focal, except when by virtue of their intensity they may *distract* attention from the copy. For example, at his first sitting subject *C* complains of "a feeling of jerkiness" and that the "muscular currents are interrupted" and significantly adds, that the process is "not pleasant." This subject was the first to break away from the visual use of the "key-board" which he did at his fourth sitting, having learned in their order the letters on the key-board. Here then was an opportunity for attention to muscular sensations to show itself if occurring at all during this period of learning. But the report for this sitting contains the statement that the subject is "conscious of the bulb to be pressed rather than of the finger to do the pressing." It is

[1] *Cf.* Book: *op. cit.*, p. 157.

only when the situation is new and highly stimulating and the consequent "overflow" considerable that the muscular sensations claim direct attention, and perhaps only then when the subject is on the lookout for them. Here again we have an instance tending to show that when learning to make movements that involve objects other than the body attention is upon the sensations arising outside the body and not upon those arising within the body.

With minor exceptions there is no evidence that during this learning period our subjects made use of either resident or remote imagery of the forthcoming movement. There is not an introspection indicating that any one thought of how the movement, about to be made, was going to "feel" or look. The only functional imagery, distinguishable from the sense and perceptual processes involved, was inner speech, and even this was at this time more or less muscular. One of the "minor exceptions" just referred to, was the idea of the result of the movement, which figured only in the dictation writing. This idea was the idea or visual image of the result of the movement of the writing point upon the drum surface. It is therefore clear that during this first and most difficult stage of control, attention is objective and perceptual.

The second stage leading towards automatization is characterized by a "short circuiting" process in which certain perceptual elements drop out, and, if consciously present thereafter, are represented by memory images. The first elimination is to be found in the disappearance of excessive eye movements over the key-board when a general idea of where to look for the letters has been reached. At this stage the different methods presented by different subjects began to manifest themselves. As previously stated, *C* consciously freed himself from the key-board very early by learning the letters for each bulb and then using the "touch method." Even on the second day "the effort is to make automatic the coördination between *memory* impressions of the letter on the cardboard and the motor impulse." On the fourth day he is "trying to avoid looking at the cardboard entirely," but he has not yet "got the letter translated into the bulb," *i. e.*, he has not "short circuited" so completely as to "take directly from list to bulb." *C*'s short-circuiting method was therefore that of eliminating eye movements over the letters on the cardboard and substituting for them the visual memory image of each letter and its location until a direct association between letter and bulb was set up. *E*, trained upon the piano, followed essentially the same method. For example, at the fourth sitting *E* "can make the movement of pressing the bulbs in shorter time than it takes to place (*i. e.*, to fixate)

the letters on the cardboard," and is already visualizing the letters infrequently and remembers their places in terms of motor activity. Here we have first the elimination of direct vision of the letters and a little later the elimination of the visual memory images of the letters, at least to a degree.

R fell into the other method, that of learning the list of words early in the practice and thus freeing the eyes for constant use upon the key-board. This eliminated eye movement from list to key-board and *vice versa*. On the second day *R* speaks of a greater ease in execution in consequence of having now "a general idea of where to look for the letters." After a few sittings *R* still further eliminated direct eye-movements from letter to bulb, so that the pressing of the bulb followed immediately upon the fixation of the letter. *R* also reduced eye-movements by gradually ceasing to fixate each letter as the corresponding bulb was pressed, and instead fixated the central part of the cardboard with only slight fluctuations on either side.

D never made direct eye-movements from the letter on the cardboard to the corresponding bulb. His method was essentially the same as that of *R*, with the exception that he used the list of words for a longer time. He did, however, early begin to eliminate eye-movements over the cardboard and the fixation of each letter. At the second sitting he thinks there is some motor memory present and finds that when the movement is once started the "visual element becomes peripheral and almost drops out." At his eighth sitting he "fixates only the central part of the cardboard and makes use of the outlying letters in peripheral vision." A day or two later he reports that he "did not have to look at the letters on the cardboard." This was on the day when eye-closed "practice" was begun. He was, however, still looking at the list of words, which practice continued for a considerable time after the words had been committed to memory.

These details have been given to illustrate what is meant by what has been called the "short circuiting" process. They illustrate the general principle of initial excess of activity which characterizes all learning processes, a principle to which voluntary movement offers no exception; for voluntary movement is genetically a learning process, though it differs from certain learning processes in this respect, that much of what is eliminated is not necessarily faulty but at the beginning useful and even necessary. It is therefore not so much an elimination incident to "trial and error" as an elimination due to what may be called a knitting up of the associative links between the various sensory and perceptual processes involved in the control.

Another fact to be observed here is that, as this "short-circuiting" process takes place, control as a whole shifts from what at first was almost, if not wholly, peripheral, involving a hunting about with effort, to what may be called a central control, securing precision and ease in the sense that the operator knows just what to look for and what to do, and in the further sense that the association links between the factors involved in control function without mental effort. In figurative language the subject has at his command a panoramic map of the whole mental situation and the transition from one focal point to the next on this map tends to become automatic. As the "short-circuiting" and knitting-up process takes place, the tendency is clearly present to pass from what was first a disjointed mass of details to what becomes a complex unity. Gradually organization comes out of chaos; and, with organization, details as such lose their distinctness and merge into a situation which in course of time requires attention not to separate details or series of sensations and images, but only to a *total situation*. But the situation does not become an attended-to situation until the "short-circuiting" process has reached a certain degree of completeness. Reduction of sensory and perceptual data to a minimum is therefore necessary to bring about a movement-situation in which the details run off without attention to them as such.

The possibility of consciously organizing a given group of movements into a control situation requiring only a single "set" of attention is therefore determined by the nature of the movements on the one hand and the span of attention on the other. Just as some of our movements surpass the physiological limit of becoming reflex—at least in a single life-time—just so other of our movements surpass the conscious limit of becoming controlled by a single "set" of attention. This "set" of attention, *i. e.*, attention to the organized situation, is the third and last stage reached in the movements under discussion. A fuller description of this "set" as it appeared in the experience of the four subjects participating in this experiment is now in order.

It is scarcely necessary to call attention to the fact that this so-called "set" of consciousness is not a purely mental state but clearly a psycho-physical condition involving the whole musculature as well as the neural and conscious aspects of the organism. It is a movement-consciousness with habituated motor tendencies. But while the motor processes accompanying and flowing from the "set" become habitual and ultimately highly automatic, and while the distinguishable *contents* of the "set" are also highly involuntary, *the maintenance of the "set" itself is the remaining voluntary aspect of the whole process.* The introspections of both E and R, with whom the "set" was most

highly developed, abundantly illustrate this fact. For example when *E*'s attention, during the last days of experimentation, wandered too far away from the process the writing stopped. The inability to continue the writing was not, however, due to "any less attention to the details" but to "lack of attention to the general situation." *R* reports that all that is required to keep up the proper movements is a certain general "direction of attention" or "general attitude," and that if this is maintained the details take care of themselves.

But if the details as such receive no attention how is it that mistakes are recognized immediately after they occur, a fact which was often noticed? If a wrong movement is recognized, it must rise to the level of consciousness as a distinct movement, and this is precisely what happens. When the movements run off correctly and smoothly we have a condition which Hobhouse well describes when he says that the "crude sensation has assimilated certain characteristics which, if disentangled, form the contents of ideas, but which are not disentangled as long as they are assimilated. Prominent among these are motor-impulses. We may call them acquired sense impulses, and say that the present stage of assimilated experience postulates sensations and feelings as its data and produces acquired sense impulses passing into habit as its result." (Mind in Evolution, p. 101.) But the sensations from wrong movements have not acquired the idea 'characters' and the 'motor impulses' that characterize the sensations from correct movements and hence at once rise to the level of distinct consciousness. They are instantly disentangled from the other contents of the "set," for they never really belonged to the "set," and being alien to it, at once attract attention when they appear. It is therefore clear that the muscular sensation or after-image of the correct movement is quite a different thing from the muscular sensation or after-image of the wrong movement. The former is reacted to as a sensation in peripheral consciousness, if conscious at all, the latter gives rise to a focal idea which calls for a special reaction. The former appears as an unnoticed element in a consciousness acting as an accompaniment or mere spectator, while the latter immediately gives rise to a consciousness acting as a "guide"[1] for each detail.

Attention to details invariably made the writing more difficult after the "set" was established. The general principle seems therefore to hold, so far as voluntary movement is concerned, that consciousness exists only to get rid of itself, and that when once rid of itself the adjusted movement runs

[1] *Cf.* Morgan: Intro. to Com. Psy., p. 189.

off best when as nearly unconscious as the conditions will permit.

This position is further supported by the fact that in no case did the "set" appear until the writing of the list of ten four-letter words had become a series of forty consecutive associated finger movements; that is, until the words, and to a degree the letters, as such had dropped out or, perhaps better, become merged with the movements and the sensations resulting from the movements, so as to be concretely indistinguishable. For example *E* reported at the close of experimentation that "general bodily sensations and tactual-kinæsthetic sensations, together with visual sensations when the eyes are open, make up the content" of the "set." This and other introspections illustrate that the gradual drift of attention is from the extra-bodily factors, with which attention is concerned at the beginning of the experimentation, toward the intra-bodily sensations as the activity becomes automatic until finally attention to details as such is lost. It is then that the tactual and kinæsthetic elements and the inner speech are observed as the only remaining sensory or ideational elements connected with the activity; and these no longer demand a shift of attention from one to the other but all enter into an organized complex with attention given to it as a whole, and without distinction of inner or outer.

This description holds only for the "practice" writing and not for writing from dictation. At the beginning of experimentation one or two of the subjects thought writing from dictation easier than from the copy, but at the close all agreed that the dictation was much less automatic than the "practice" writing. The reason for this is found in the fact that after the "set" had developed to a certain degree the dictation (a word at a time) periodically interrupted a process which had become continuous and automatic.

The dictation writing at this stage illustrates two of Ach's observations, namely, the presence of intentionalen Bewegungsempfindungen and the absence of imagery between the reception of the word and the following movement. (*op. cit.* p. 146.) In dictation the subject develops, so to speak, a special or temporary "set" for each word by running through the word in inner speech with reference to the letters on the cardboard or the corresponding bulbs or fingers, depending upon the degree of automaticity already attained. In early practice this process was repeated essentially *after* hearing the word and *before* beginning to write, but after the appearance of the "set" there was no discoverable imagery intervening between the apperception of the word and the beginning of writing. What is found is simply a psychophysical "set" for the par-

ticular word anticipated, and with the reception of the word the release of the motor consequences (temporarily inhibited) of this "set," which already contains the movement in embryo.

Inner speech continued throughout experimentation, but in the fully developed "set" it cannot be regarded as the motor cue. That it cannot by itself be regarded as the cue is shown by the fact that not infrequently the movements outstrip the inner speech for the corresponding letters. *That neither inner speech nor any other single factor can be regarded as in itself the cue is further demonstrated by frequent instances in which the movements were ahead of any sort of consciousness of the process.* In fact, with both *E* and *R* in the last days of practice the moter impulse was at times clearly ahead of all detailed conscious processes. When consciousness of the movement came into the process at such times it always came in just a little behind what the fingers were doing. But this is not to be interpreted to mean that consciousness had nothing to do with the movements and that the latter had become purely physiological. Far from it. There was a distinct limit to both the separation in time and the nature of the possible withdrawal of consciousness from the movement. If in rapid writing the movements succeeded each other so rapidly that the consequent sensations merged into a sensation-mass and inner speech became indistinguishable or some of the letters were slurred or omitted, the "set was broken and control was momentarily lost. Again all the subjects found it possible at the close of experimentation to think of other things while writing, without interference. But here, too, there was a limit. It appears that, as one subject observed, considerable quasi-irrelevant imagery may enter consciousness without serious disturbance, provided it is all related to the writing. This irrelevant, but non-disturbing, imagery is only momentary "like a flash" or "like a dream." Otherwise the writing "set" is disturbed, if not actually broken up.

This brings us to another point in the discussion, namely the difference between the "set" with eyes open and with eyes closed. There are two differences, a difference in the rate of the writing and a difference is distractability. Some of the subjects were inclined to think, on purely introspective grounds, that they wrote as rapidly with eyes closed as with eyes open. The facts (as revealed by the special records of the "practice" writing taken for this purpose without the subjects' knowledge) are, however, that *in every case* the eye-closed practice was slower than the eye-open; and this in spite of the fact that only two of the subjects visually regarded the card-board containing the letters. This is shown in the following table of averages

for writing the list of ten words or forty letters. *R*'s averages are based upon 50 records; *E*, *C* and *D*'s upon 30 records each. The numbers express fifths of a second.

	Eyes open	Eyes closed
E.	28.2	29.7
R.	35.6	39.7
C.	47.8	54.7
D.	52.5	70.2

D and *C* show the greatest differences. *D* practiced with eyes upon the cardboard in open-eye practice while *C* did not. Whatever the reason for these differences, it is clear that open eyes facilitated the writing even when the cardboard and bulbs were not regarded. It is possible that these time differences are due to differences in liability to distraction. This latter difference shows itself in the difficulty with which eye-closed practice records were obtained. Not only were mistakes more liable, but there were actual "break downs" when the attempt was made to obtain the eye-closed records, due to more pronounced consciousness of the rotating drum, etc. Such broken records were of course not used in obtaining the above averages. It is possible that the eye has a steadying effect upon voluntary movement, because of the original close connection this sense organ sustains with all our voluntary activities involving objects or extra-bodily space. It is possible, too, that vision aids by holding the external circumstances of the experiment in consciousness, at least in a peripheral way, and thus by association helps to maintain the "set." At any rate the "set" of consciousness here described was more readily maintained in eye-open than in eye-closed practice.

To summarize, The automatization of a highly voluntary movement like the one here studied, involves the three following stages:

1st. A period of perceptual attention to details in which vision plays the leading rôle, the muscular sensations being only marginal, unless abnormal conditions, subjective or objective, force them into the focus of consciousness.

2nd. A transitional period, or period of adaptation, which is characterized by three things: (a) A process of elimination of perceptual data and, in instances if not in all cases, the substitution of memory imagery, for a longer or shorter period, for the eliminated perceptual data. (b) A gradual lessening of the intensity of attention and of general psychophysical tension. (c) The development of an organized "set" of consciousness in which the details no longer require attention in themselves but only as parts of a complex whole, the elements

of which are sensuous, rather than perceptual, but have yet the *motor* significance of perceptual or sense data attended to.

3rd. A period in which the volitional part of the process consists only in the maintenance of the "set," the details which enter into it taking care of themselves, provided the "set" is not disturbed beyond a certain degree of habitual fluctuation.

The bearing of these experiments upon the general nature of voluntary movement may be summarized as follows:

(1) Where a movement involving external objects is new and highly volitional, attention is normally objective, dealing with *percepts* of the *immediate*, rather than with *images* of *past* movements.

(2) Those sensations are functionally most important which reveal the present situation most faithfully in accordance with the tendencies of the individual and the exigencies of the situation.

(3) Kinæsthetic sensations become prominent, but do not *necessarily* take on guidance value, when the situation is complex and stimulating.

(4) It is only when a certain degree of skill and proficiency has been reached that imagery (in contradistinction to percepts) of any sort becomes important. This imagery was uniformly derived from the preceding perceptual experiences in making the movements (voluntarily) and *not from reflex and involuntary activities*. In other words this imagery has a *conscious* source. The experiment affords no evidence for such a thing as imagery derived from purely reflex and unconscious experiences.[1]

(5) It does, however, afford evidence that much of the control imagery as such fades away with practice and that in the last stages of a voluntary movement a complex idea of the general situation, with little or no *particular* imagery of a clear character, is sufficient to carry on a series of practiced movements. In this stage the sensations arising from the movements themselves to not necessarily give rise to perceptions, but perform their proper functions without the aid of supplementary ideational processes.

(6) There is some evidence that this complex idea or "set" of consciousness may in the case of such movements as those of type-writing be purely verbal so far as its image aspect is concerned, although the eye-closed writing gives evidence that concrete sensory processes facilitated the writing even at the end.

[1] It must not be forgotten, however, that the movement of pressing a bulb (as would in fact be true of almost all movements of adults) was not a wholly new muscular performance but rather a special adaptation of a movement already at command in a less specific form.

II. Writing Experiments, Involving Different Degrees of Practice and Volitional Control

The tests used were the following: (a) Copying a list of familiar English words. (b) Copying two-syllable nonsense words. (c) Copying German words. (d) Copying the English words while tapping with the left foot. (e) Copying the nonsense syllables while repeating the Greek or German alphabet. (f) Writing the subject's name and address upside down with the left hand. (g) Writing the name and address with the left hand while shielded from direct vision and controlled by means of the reflection of it in a mirror placed before the paper.[1]

With the exception of the upside-down writing and the mirror writing, which were not timed, one minute was allowed for each exercise. In all eight subjects (graduate students in psychology) served for these experiments, each subject taking the seven tests at least twice and in some instances three times. The general uniformity of the results warranted stopping this set of experiments with this limited number of tests.

In the discussion of the writing experiments it may be well to call attention at the outset to the physiological complexity of the movement. Physiologically writing is a highly complex activity involving the co-ordination of movements at six joints from the shoulder to the first joint of the fingers. With these movements, so intimately related to one another, must also be correlated the movements of the eyes and to an extent those of the head and body. Our problem is how these co-ordinations are controlled. It is to be observed at once that we are not immediately aware of any of the co-ordinations mentioned. It is only by reflection upon the act of writing that we become aware of them in any definite sense. Another palpable observation is the fact that writing involves fineness of movement and co-ordinations and therefore fineness of discrimination somewhere on the side of control, for it may with safety be assumed that sensory discrimination, conscious or unconscious, is directly related to accuracy and delicacy of movement and it is certainly conscious in some measure until the movement becomes habitual or automatic.

If then, with this delicacy of movement and fineness of sensory discrimination in mind, we ask what on *a priori* grounds is the sense organ that primarily controls such move-

[1] It is only fair to state that these experiments were complete before the publication of the somewhat similar ones of Dr. Downey mentioned in the preceding section.

ments, especially in its early stages, the eye at once suggests itself. In the experiments here described the tendency to use the motor cue as the focal element is nowhere in evidence except in the upside down and mirror writing. Muscular sensations are occasionally mentioned in the other tests but never reported as focal. Moreover, it is very likely that the introspective attitude was influential in rendering them focal in the tests in which they so appear. A comparison of the tests in which kinæsthetic sensations appear as focal brings out an interesting fact. When, *e. g.*, in the writing with mirror guidance, interpretation of the visual process is made necessary by the conditions of the experiment while the movements themselves are in no wise changed from normal writing, the subject falls back upon the use of motor sensations as the focal elements almost in spite of his effort to the contrary. That is, the tendency to follow *directly* the visual cue given by the mirror and thus make the wrong movements is so strong that to write correctly requires the neglect of vision until a new co-ordination is started when the mirror cue can be used directly. This, we think, shows clearly what a predominant function vision normally assumes in our writing reactions, especially when beginning.

In the upside down writing *the* difficulty was to visualize the *letters* upside down, *not* the movement nor to have an anticipatory image of how the changed movement was going to feel. This primary difficulty of visualizing the letter in the reversed position was experienced by every subject, but was met and overcome in various ways by different subjects. Some succeeded in visualizing the letter upside down, two visualized themselves as sitting "on the other side of the desk" while one thought "of how the hand should go" and of the muscular sensations when the movement was once started. Attention is called to the fact that in the mirror writing (*i. e.*, writing with work reflected in the mirror) what is being put on the paper is constantly flashed back to the eye in a reversed position, and that the *sight* of this reversed position tends immediately to reverse the movement, while in the upside-down writing the subject sees what is written *as* it is written. In the latter the vision controlling the movement is direct and correct; in the former it is indirect and reversed. In the upside-down writing the muscular sensations were theoretically radically changed from normal writing while the subject's vision of what he was doing was not interfered with, but in the reflected writing the muscular sensations theoretically were the same as under normal conditions and actually should be the same so far as the movement itself is concerned, while the subject's vision of what he was doing

was radically changed, making a condition in essentials the reverse of the upside-down writing. It is therefore clear that in writing movements the muscular element can be changed (not eliminated) with less interference with the activity than is produced when the visual element is changed.

This suggests that on the sensory side writing may be regarded as a visual-kinæsthetic activity with vision representing the extra-bodily aspect of the total process and the muscular sense the intra-bodily aspect. As a matter of fact it would seem that every new voluntary activity whose object is an extra-bodily end requires the sensory or perceptual representation of those two aspects of the process and these two only, the one representing the *status quo* of the thing being manipulated, the other that of the bodily member immediately concerned with the manipulation. Our writing experiments show that in the more highly volitional tests attention is uniformly upon the extra-bodily aspect unless conditions are such that reaction to the visual elements can take place only by way of complex interpretation. The study of the cases of anæsthesia (to be described later) will show that the muscular sense normally serves the function of giving the *status quo* of the bodily member, but that in case of tactual-kinæsthetic paralysis vision is called upon to perform this function. These facts agree with the facts obtained in the present study. Moreover the facts there obtained agree also with those obtained in the writing experiments in this, that in the automatization of voluntary movement the extra-bodily elements drop out of consciousness before those representing the position of the member in movement. This is abundantly illustrated by the fact that every experiment with the upside down and mirror writing shows attention to the result, and not only that, but *visual* attention wherever it is practically possible. On the other hand in those experiments in which the movements and the manner of control were familiar but the copy unfamiliar and meaningless, as in case of the nonsense syllables, there was a minimum of attention to the result. The same thing is true of copying nonsense syllables and repeating the Greek and German alphabet. In this case attention fluctuated from the copy to the alphabet but not to the result put on paper. In both these cases the handwriting suffered somewhat, as is shown by comparison with the other experiments in which there was visual attention to the result. It suffered not only in the large co-ordinations such as following the line, spacing, etc., which involve a spatial reference for which the muscular sense is inadequate, but also, in instances in a marked degree, in the details of the movements which apparently have "gotten into our muscles" and which

in normal writing under visual guidance receive practically no attention. Ordinarily we write with the eye focussed upon the paper at or near the point of the pen while attention may be, and usually is, far away from the movement as such. In fact, consciousness of the finer aspects of the movements involved seems to be next to nothing, yet the slight peripheral visual consciousness (it cannot be called attention) is evidently of great value in furthering the co-ordinations.

In such controlled reactions as copying words under conditions involving varying degrees of difficulty there are three things we *may or must attend to or be conscious of*, depending upon the conditions and the difficulties involved. These are the copy, the result, and the position and movements of the bodily parts active in the production of the movements. Attention to, or consciousness of, the first two is always visual. It is moreover highly probable that in the *early* stages of writing the visual *attention* fluctuates between these two and the third. The position is, however, never normally *attended to* without resulting in distraction. Of these three factors the *details* of the result, as already shown, drop out of consciousness comparatively early. It is precisely these details which in the early stages of learning to write give the most difficulty and which are attended to most closely. It is here tentatively suggested that this principle holds for a large range of our acquired activities. This much seems clear, that consciousness of position either by means of the resident sensations or by means of the visual and remote sensations is necessary long after the details of the result have dropped out. It is highly probable that in coördinations that are far removed from our inherited reactions, like writing, consciousness of position can never drop out with impunity. The long continued practice that is necessary to reestablish walking (which at most is only partially a learned reaction) without the aid of the eye, in cases of sufficient tactual and kinæsthetic anæsthesia to destroy the sense of position, is strong presumptive evidence in favor of such a view.

Two other considerations of interest with reference to the automatization of writing movements are the behavior of inner speech and the appearance of more or less irrelevant imagery as the process becomes easier. The inner speech, more generally mentioned than any other one thing, is universally present in the copying of nonsense syllables and German words. The introspections contain only two observations of it in the upside down and mirror writing and these by the same subject. But this fact, we believe, does not justify the conclusion that these instances show that it was not generally present. It seems probable that if present, its infrequency, due to the slowness of the

writing and the objective nature of attention, might easily account for its being overlooked in the introspections. This much, however, seems clear, that inner speech rises into distinct consciousness whenever the *meaning* of what is being written is not at once present. Whenever the ideational processes resulting in or constituting meaning are blocked, inner speech at once comes into clear consciousness. And probably also when anything hinders attention to the writing. But, although the introspections are inconclusive upon this point, there are indications that, in spite of its greater prominence, inner speech is little more than an accompaniment when the copy and conditions are unfamiliar and difficult and that it is more distinctly a cue when the copy is familiar and the conditions easy. Evidence for this is found in the constancy with which the eye is kept upon the copy when the former conditions prevail and its desertion of the copy in the latter conditions. That is, when the eye has to be kept upon the copy the writing becomes more nearly an act of drawing; in fact that is what it amounts to in the upside-down writing where the primary difficulty is one of visualization.[1] If this view is correct, it follows that inner speech unaccompanied by ready meaning, does not in itself serve as a cue. The inner speech, in this case is probably primarily of service in the development of meaning and not in the direct control of the movement. More exactly it is not so much a control factor as an initiatory element; it is the element with the appearance of which meaning is primarily developed.[2]

The facts brought out in this set of experiments tend to show in connection with the preceding experiments, that in a general way the content of consciousness *changes* rather than diminishes

[1] The copy was, of course, *not* presented upside-down.

[2] It is, however, not to be assumed that the same explanation is offered for the function of the auditory image (which is always present in inner speech and constitutes an aspect of the latter) in the case of actual speech. That the auditory image has a direct control over speech regardless of meaning in any specific sense is readily demonstrated by the child's ability to enunciate more correctly than most adult beginners the sounds of an unknown language. That the auditory image is *primary* in such control is also evidenced by the methods employed in teaching deaf mutes to speak. *Cf.* Farrar: Arnold's Ed. of the Deaf, pp. 127-128. This position is uniformly supported by reports of methods employed in teaching deaf mutes to speak at several institutions for the education of this class of defectives. This statement from one of them is illustrative. "Absolutely deaf children always remember the visual appearance of the word on nose and lips and associate this with the feeling produced in them when they give the same sound. Only the blind deaf make a constant practice of touching another's lips. Those who have some hearing left, probably have an idea of the sound of the word when they speak it. This largely takes precedence of all other impressions."

as movement becomes easier. The decrease of associations and the growing absence of irrelevant imagery as the subject goes on from the copying of simple English words up to the upside-down and reflected writing (in which they do not occur at all) shows that as attention becomes more necessary and more concentrated the range of consciousness narrows; and the converse is also true, as attention becomes less concentrated, the range of consciousness becomes wider, and more or less extraneous imagery appears. It is therefore clear that in case of easy movements attention responds more readily to other stimuli and as a consequence becomes a mixed process, including, so far as the movement is concerned, both relevant and irrelevant elements. It would therefore be easy to fail to see the woods because of the trees and report no imagery when in reality it may have been present. As a matter of fact there are here two things to be kept distinctly in mind; the first is that in highly voluntary movement, but not too difficult to permit *Zerstreutheit*, attention is intense and consciousness narrow, and therefore the imagery or sense data are strictly limited *at any given pulse of attention*. The second fact is that in well learned and facile reactions the attention to the activity is minimal and the range of consciousness correspondingly wide. Strictly speaking it is therefore not true, at least from the point of view of the objective movement which it produces, that consciousness is always a unitary process, for clearly the most important elements in the configuration of consciousness may not always participate in the production of a specific movement.

III. Anatomical, Physiological and Pathological Data

It is the purpose of this section to review, as succinctly as the complexity of the subject will permit, the leading anatomical facts and physiological experiments, together with a number of pathological cases of anæsthesia, that have a bearing upon voluntary movement.

1. The Anatomical Facts as reflected in Recent Neurological Literature.

Recent neurological studies on the relative number and distribution of sensory and motor fibres in the peripheral nerves throw a certain light upon the relation of sensory impulses to voluntary movement. Donaldson has pointed out that, "Taking the central system segment by segment, the sensory nerves are more numerous and have a greater area than the motor. In man, as we pass cephalad, the superiority of the sensory nerves becomes most marked,—"(Growth of the Brain, p. 196.) Ingbert counted the nerve fibres of the left dorsal roots of a man weighing 180 lbs. and found the total number for the left side to be 653,627 which would give a total, for both sides, of

1,307,254, assuming that the innervation is the same for both sides. Ingbert also counted the fibres in the ventral roots of the same cord and found the total number, for both sides, to be 407,400. This would make the ratio of sensory to motor greater than 3:1 and at once suggests James's figure of a "funnel" with the big end representing sense processes and the small end movements.

Of still greater interest from a psychological point of view is Ingbert's table showing the number of fibres for each spinal segment. The curve for these figures shows in a striking manner that the number of fibres and the area of the nerves representing sensation from the more mobile and voluntarily controlled parts of the organism, particularly the arms, are very much greater in proportion to mass than they are for the less controlled organs. While there are no data demonstrating it in detail, roughly and in general, at least, one may say that sensory innervation is directly proportional to mobility and voluntary control. This position is supported by the experiments of Van Biervliet on "*Le toucher et le sens musculaire.*" (L'Année Psy., 13, 1906, pp. 114-121.) Van Biervliet found that sensibility to touch is directly proportional to the mobility of the organ and that sensitivity increases with practice and skill in control.

Further light is thrown on these anatomical facts by Head's recent study of peripheral sensibility. ("The Consequences of Injury to the Peripheral Nerves in Man." *Brain*, 1905, pp. 116-338, and "The Afferent Nervous System from a New Point of View." *Ibid.*, pp. 99-115.) Head distinguishes three forms of peripheral sensibility:

I. "Deep sensibility, capable of answering to pressure and to the movements of parts, and even capable of producing pain under the influence of excessive pressure, or when the joint is injured. The fibres, subserving this form of sensation, run mainly with the motor nerves, and are not destroyed by division of all the sensory nerves to the skin." (p. 111.) "Deep sensation is not materially affected by the destruction of all the nerves to the skin, and it must reach the central nervous system by fibres that run in other channels than the so-called sensory nerves." (p. 215.)

II. "Protopathic sensibility, capable of responding to powerful cutaneous stimuli, and to the extremes of heat and cold. This is the great reflex system producing a rapid, widely diffused response, unaccompanied by any definite appreciation of the locality of the spot stimulated." (p. 111.)

III. "Epicritic sensibility, by which we gain the power of cutaneous localization, of the discrimination of two points, and of the finer grades of temperature, called cool and warm." (p. 111.)

In an article "On the Anatomical Constitution of Nerves of Skeletal Muscles." (*Journal of Physiology*, Vol. 17, pp. 211-258.) Sherrington reports a study of sensory and motor fibres supplying different muscles. He says: "Taking the whole series together, the average proportion of the afferent fibres to the total myelinate fibres in the nerves of the muscles examined proves to be a little less than a half (49%). The proportion of afferent fibres to the total myelinate fibres ranges from a little more than a third in some muscular nerves to a full half in others." (p. 229.) "In the nerves to some muscles the afferent fibres are as numerous as the efferent. It is probable that the very largest cells in the spinal ganglia belong to some of the nerve-fibres of the muscle spindles. Probably in every spinal ganglion a number of the nerve-cells belong to the sense organs of muscles." (The Spinal Animal. *Medico-Chirurgical Translations*, Vol. LXXXII, p. 455.)

Dunn caused all the motor nerves to the legs of a frog to degenerate and "found that there remained an ample supply of medullated fibres to the muscles. These represent from 15 to 30 per cent. of the fibres going to the muscles."

Assuming that the relative motor and sensory nerve supply to the voluntary muscles of the guinea pig and white rat is approximately the same as it is for the animals studied by Sherrington and Dunn, we have in their results an excellent neurological basis for the psychological results obtained by Small and Watson with the rat and Allen with the guinea pig. (Watson, *Mon. Sup., Psy. Rev.*, May, 1907. Small, *Am. J. Psy.*, Vol. 12, pp. 206-239. Allen, *Journal Comp. Neur. and Psy.*, Vol. 14, No. 4.)

Both Small and Watson, especially the latter, found that kinæsthetic processes play a highly important, if not a preponderating rôle in the controlled movements of the rat when learning to run the maze. Allen found that in case of the guinea pig "vision is an important element" but that the "labyrinth is not learned solely, or even largely, in terms of tactual sensations." Her conclusion is that "kinæsthetic sensations are of great importance in the recollection of a path." (*Op. cit.*, pp. 330, 336 and 337.) Yerkes working with the frog came to practically the same conclusions, finding that "beyond question vision and the direction of turning were all important factors in the establishment of the habit." (*Harvard Psy. Stud.*, I, p. 579.)

In connection with what Allen finds to be true with the guinea pig, it is interesting to recall that frequently in human cases of locomotor ataxia the cutaneous sensibility escapes injury while the muscular sense always suffers more or less and

with a corresponding effect upon co-ordination. Head's cases on the other hand clearly illustrate that the loss of *tactile* sensations alone in man has little or no effect upon voluntary movement.

2. Physiological Experiments.

In order to determine the effect of the loss of "resident sensation upon movement, Mott and Sherrington working on the monkey severed the dorsal roots on one side of the cord supplying the arm and leg with sensory innervation, viz., the 4th cervical to the 4th thoracic inclusive, and the 2d to the 10th post-thoracic inclusive. The results are described in their own language as follows: "From the time of performance of the section onward as long as the animal may be kept [they kept them about four months] the movements of the hand and foot are practically abolished. On the other hand, the movements of the elbow and knee, and especially the movements at the shoulder and hip, are much less impaired. If the feeding time be deferred, and an animal, in which the apæsthete limb is an arm, be tested by offering it fruit after the sound arm has been secured behind the back, there is no attempt to use the apæsthete limb for reaching the food, but the neck is thrust forward in order for the mouth to seize it." One monkey tried to take food with the apæsthete foot but failed,—"the digits were not moved." "The defect in motility increases from the attached base to the free apex of the limb; so that, for instance, while comparatively slight at the hip, it is successively greater at the knee and ankle, and greatest (amounting as regards volition, to absolute loss) in the digits." The authors conclude that volition "has been absolutely abolished by the local loss of all forms of sensibility." (*Proc. Roy. Soc.*, Vol. 57, pp. 481 ff.)

Bastian, on the other hand, while accepting these facts criticises Mott and Sherrington's interpretations. *Brain*, Vol. 18, pp. 609 and 615. Bastian argues that limb movements may be paralyzed or rendered defective in two ways: (a) by organic lesions (b) by functional defects. These functional defects are of two sorts: in the one case the "seat" is cerebral, in the other, spinal. He says that "in cases of complete hemianæsthesia due to lesions or functional defects in the posterior part of the internal capsule, there is not only no paralysis, but little or no impairment in the ability to perform, under visual guidance, even the most delicate movements with the apæsthete limbs." As is well known, Bastian holds that there are no motor centres strictly speaking, that what we call motor centres are essentially kinæsthetic centres and that impulses have to pass through these centres before a movement can be made, but that these impulses may originate in the auditory centre

as in speech or in the visual centre as in hand movements, and therefore there may be controlled movements without kinæsthetic sensations from the limb to be moved.

Sherrington, however, writing after further experimentation bearing upon the relation of sensation to movement seems to modify somewhat his original rather rigid and sweeping position. He writes: "It is found that the destruction of sensitivity in particular regions brings about objectively observable disturbances of movement." . . . "the effects of apæsthesia upon the musculature of the part are three—(1) paralysis, (2) ataxia, (3) atonia." (*Proc. Roy. Soc.*, Vol. 60.)

Munk repeated the experiments of Mott and Sherrington and at first obtained the same results, but later found that monkeys recovered to a degree their ability to use the hands that had been rendered anæsthetic. These movements, however, were always inaccurate and exaggerated. Moreover only single voluntary movements could be made at all. Munk's animals at first dropped food placed in the anæsthetic hand but later learned to grasp it and carry it to the mouth. After getting it to the mouth the monkey at first removed the fingers from the food with his teeth but after some practice learned to let go "actively" when the hand reached the mouth. Then instead of placing the food in the monkey's hand, Munk simply presented it to him. With the sound hand tied behind him the monkey after experience learned to take the food from Munk's hand and carry it to his mouth with the anæsthetic hand.

What Munk specifically denies in Mott and Sherrington's deductions from these facts is that the entire sensory mechanism is and must be operative in voluntary movements, that the entire sensory path from the periphery to the cortex is necessarily active in volitional control. Munk points out that the only movements that are entirely and permanently destroyed are the reactions that normally take place to an immediate stimulation of the member concerned. All other movements which the extremity normally makes are more or less defective because the "*Einstellung der centralen Organe von welchen die Bewegungen der Extremität herbeigeführt worden, verändert ist. Die Störung ist immer desto grösser, je mehr Muskeln oder Gleider der Extremität an der Bewegung beteiligt sind.*" The important differences between Mott and Sherrington and Munk appear to lie in the fact that the former seem to regard kinæsthetic elements as the essential sensory elements in the voluntary arc, while the latter holds that any sense elements, visual, auditory, etc., will serve the same purpose quite or nearly as well in the absence of kinæsthetic elements, especially after practice.

It will be recalled that Sherrington found that in the spinal frog "the initial posture of the limb distinctly affects the character of the reflex movement—even in the absence of cutaneous organs." This fact, together with Munk's results and criticism of Mott and Sherrington, takes us again to Judd's position that in the animal relatively low in the phyletic scale the kinæsthetic areas play a more important function than they do in the higher animals for the reason that in the latter the special senses have become more highly differentiated and have accordingly, to a degree at least, usurped the original primacy of kinæsthetic centres and therefore play a more important part in volitional activity. However hypothetical Judd's position may appear, it certainly possesses the advantage of facilitating interpretation, an advantage which warrants its application. If we assume that the original undifferentiated form of sensation is of the tactual-kinæsthetic type and that from this original type all other forms of sensation have been gradually differentiated, it is clear that in animals low down in the scale of evolution the original type of sensation must necessarily perform the important function of *the* sensory cue for voluntary movement. On the other hand, in animals high in the same scale the other sense processes are so highly specialized and developed that, when measured in terms of relative discrimination, they far surpass the original type from which they took rise, and may now play the principal rôle in voluntary action. Moreover if in making a new and conscious adaptation—which involves discrimination and choice and therefore voluntary movement—the important thing is the correct grasp of the situation rather than the consciousness of the movement as such, then it also follows that the sense organs of later development naturally play a primary rôle for the reason that their discrimination is finer, and for the additional reason that they act at a distance.[1]

(3) Pathological Cases. Disease has done, not infrequently, what is impossible to experimentation upon human beings; it has destroyed the sense processes, and given us the general relation of these processes to voluntary movement in very much the same way as the physiological experiments of Mott and Sherrington and Munk reveal them in the case of the monkey. It is therefore in place to review here a number of typical cases of anæsthesia and to attempt an interpretation of their bearing upon voluntary movement. One naturally begins with Strümpell's celebrated case. Of the extent of this boy's anæsthesia James says that he "was totally anæsthetic without and within

[1] *Cf.* Sherrington: The Spinal Animal (*Medico-Chir. Trans.*, Vol. LXXXII, p. 475.)

save for the sight of one eye and the hearing of one ear." (Principles of Psy., Vol. I, p. 376.) It appears, however, from Strümpell's own account of the case quoted by James, that in "violent forced hyperextension of the joints, especially of the knees, there arose a dull vague feeling of strain, but this was seldom precisely localized." (Prin. of Psy., Vol. II, p. 489.) These poorly localized, kinæsthetic sensations seem, however, to have been of some service, for Strümpell tells us that with his eyes closed, the boy could readily raise his arm at command. Another anæsthetic case of Strümpell's is cited by James in which "The arm could *not be moved at all* [italics James's] unless the eyes were opened, however energetic the volition." (Prin. of Psy., Vol. II, p. 491.)

In "Ein Fall von aphasischen Symptomen, Hemianopsie, Amnesthetischer Farbenblindheit und Seelenlahmung, (*Archiv ür Psychiatrie und Nervenkrankheiten*, Vol. 25, 1893.) Bleuler describes a case of total anæsthesia on the right side. Of its effect upon movement he says: "If the patient does not see his right arm, he not only does not know where it is, *but cannot innervate it at all.*" In summing up his observations upon these phenomena Bleuler says, "It is known that patients who are not at all aware of the effects of their muscular innervation are no longer in a position to make spontaneously purposive movements." He cites the case of Niemeyer and Späth whose patient, an "Anæsthetische Tabetiker," fell down while standing or sitting if he closed his eyes. He cites also the case of Ziemssen and Heyne, whose patient was entirely anæsthetic with the exception of his face and hearing, and who could not speak when his ears were stopped.

A. Pick describes a case (Ueber die Sogenannte 'Conscience Musculaire,' *Zeit. für Psy. und Phys. der Sinnes*, Vol. 4, pp. 175 ff.) in which the patient (a young woman) presented 'eine nahezu die ganze Körperoberfläche einnehmende Anästhesie und Analgesie.' On the right side there was complete loss of both superficial and deep sensibility. In all experiments involving hand movements this patient sharply fixated her right hand, which was completely anæsthetic. This fact, Pick points out, does not agree with Binet's (apparently *a priori*) contention that, other things being equal, attention would be fixed by preference upon the sensible half of the body, because this is the only part which gives the muscular sensations during movement. Pick's patient was unable to hold the left arm horizontally extended and at the same time make the movements of playing the piano with the right. She could, however, hold the right hand extended and make such movements at the same time with the left with-

out serious disturbances. If with eyes closed, the patient is asked a question she merely moves her lips in reply but upon opening her eyes declares she answered the question aloud. If her ears are closed and she is handed a written question she again merely moves her lips in reply, declaring when her ears are opened that she replied aloud. If she is requested to open and close her hands she accomplishes the movements by fixating the right hand. But if the right hand is placed outside the narrow field of vision the movements cease. Two interesting facts appear in this case: (a) when the sense processes are reduced to a certain minimum the movements called for, if executed at all, are reduced to a certain minimum of intensity. (b) In the two hand movements the left hand is controlled by means of the "resident" sensations while the right hand is controlled by means of vision or "remote" sense processes. In other words, either resident or remote sensation is essential for the control of each arm, the coördination (apparently) taking place when the one is controlled by "resident" and the other by "remote" processes.

Pick also cites the cases of Duchenne who observed three patients with total loss of sensibility on one side. Duchenne found that they were unable to move the anæsthetic members without the aid of vision. Both Pick and Duchenne explain their cases wholly in terms of attention. This explanation may be criticised on the following grounds: (1) Attention is not a psychic entity, as these authors appear to imply, but only a state of psychic processes. (2) As a state of psychic processes attention is, to quote Pillsbury, merely "an increase in the clearness of one idea or group of ideas at the expense of others." (Attention, p. 11.) (3) To attend there must be something to attend to, which is what is wanting to the anæsthetic. That attention is an important factor in all forms of voluntary movement would probably be conceded by every competent observer, but that attention cannot create sensations and ideas but only render them conscious, or better, more clearly conscious, must be *conceded with equal readiness.* And what the facts show in these cases is *primarily* a loss of sensations and ideas normally functional in voluntary movement.

Bleuler also rejects the explanation in terms of attention on the ground that his case showed no marked disturbances of attention *when getting sensations.* In place of this explanation Bleuler offers the following. He points out that we never take notice of the particular muscles concerned in making movements. "Unser bewusster Wille innervirt also nicht bestimmte Muskeln, sondern er führt mit den Gliedern bestimmte Locomotionen oder bestimmte Thätigkeiten aus."

"When we reach for an object we move the hand to the right or left as may be necessary, but in turning the hand to the right the opposite muscles are used from those used in turning to the left. But in all such movements the conscious process, the desired activity remains the same." Bleuler holds, too, "gewisse Kenntniss der Ausgangsstellung ist also zur Ausführung der meisten bewussten Bewegungen unentbehrlich."

Berkley reports "A case of General Cutaneous and Sensory Anæsthesia" (*Brain*, Vol. 23, pp. 111-138), in which, besides total blindness and partial deafness, there was almost total loss of the two forms of sensibility called by Head Protopathic and Epicritic but with only partial loss of "deep" or muscular sensibility, *i. e.*, there was total loss of "thermic, pain, olfactory, gustatory, equilibrium, pressure and weight sensations," and almost total loss of the visual but only partial loss of the muscular sense. "With auditory perceptions a progressive dulling could be noted." In fact "none of the special senses or cutaneous sensations remained wholly uninvolved." Considering the degree and extent of anæsthesia, this case presents two striking considerations: (1) "The musculature, while responding to the will, did so in such a feeble manner that the patient was incapacitated from helping herself to any extent. Thus the dynamometer, when taken in the hand and squeezed, was so feebly compressed that the indicator showed no movement of the dial, though the woman exerted every effort in the trial." This in spite of the fact that both nerves and muscles responded promptly to the galvanic and faradic currents, and in spite of the fact that the autopsy revealed no emaciation. (2) The second fact to be noticed in this case is that "throughout the long course of the illness there was never the slightest departure from normal mentality on the part of the patient." It is therefore clear, that so far as this case is concerned a general loss of sensibility affects voluntary movement more seriously than it does the ideational processes.

Spiller reports a case of anæsthesia in which a loss of muscular sensation resulted in inability to control the member unless it was kept in the field of vision. The "sensations of touch, pain and temperature are diminished in the left, but not to the same degree as are the sense of position and stereognostic perception." ("Separate Sensory Centres in the Parietal Lobe for the Limbs," *Journ. of Nerv. and Mental Diseases*, Vol. 33, pp. 117-121.) The defects of movement accompanying these sensory disturbances are described by Spiller as follows: "The movements of the left upper limb are awkward, although the limb can be moved freely at all

parts, and is not weak. The patient is unable to button his coat with his left hand alone when his eyes are closed, because of incoördination of the fingers, but can button it promptly with his right hand." (pp. 119-120.)

F. Pick describes a case which, besides other complications of partial anæsthesia, presented total ("constant totale") anæsthesia of the left side. While unable to imitate with the right leg passive movements of the left (anæsthetic), this patient could under visual guidance readily imitate with the left leg passive movements of the right. With the aid of vision he could, though hesitatingly, raise the left arm, but with eyes closed he was entirely unable to do so. However, if one passively bent the right arm (the eyes being closed) and repeated the command to bend the left or anæsthetic arm, the command was "promptly" obeyed and the movement made "in der gleichen Weise." (Ueber Transcorticale Störungen des Bewegungsapparates, *Deutsches Archiv für Klin. Med.*, Vol. 76, pp. 144 ff.)

Hoppe describes a case of almost complete anæsthetic paralysis of the right arm, together with "well marked amnesic aphasia," besides other more or less complete disturbances of sensibility. (Soul Paralysis, *Jour. of Mental and Nerv. Diseases*, Vol. 32, pp. 145-159.) With reference to the sensibility of the arm the author says "the muscle sense and sense of position of limb" are "almost absent." Muscular power, however, is "almost normal." The effect of anæsthesia upon movement is described as follows: "The arm is completely paralyzed, has not moved at all during the four weeks since onset of trouble. The arm is flaccid, relaxed, reflexes are absent, upon being requested to move the finger or hand, was not able to make the slightest movement, although she made an attempt to do so, showing that she understood the request. Very often, later on, a request to move the right hand was answered by the movement of the left hand. If the patient, however, was told to watch the doctor's hand and then to repeat the movement, the movement could be executed at once. Then the apparently completely paralyzed hand was made to extend and flex the fingers and thumb, to spread them wide apart, and to flex and extend the hand on the second day. Inside of a week all the normal movements of the arm and fingers—flexion, extension, moving of arm and placing hand on head and elevating shoulder could be done, usually only after she first saw the movements executed by the physician, *and only then when she was told to watch the movement closely.*" (pp. 147-8. Italics mine.) With reference to the arm, Hoppe's résumé of the sensory and motor disturbances in this case is as follows: ". . . right sided diminution of sense of

touch, pain, muscle sense, and sense of posture. Condition of motor function: an absence of real paralysis in right arm and leg, but the arm is not used spontaneously for voluntary acts: lies as if paralyzed along side of patient; arm is used for reflex acts, like scratching, and for unconscious acts, like bracing herself when arising from a sitting or recumbent position to a standing one. When shown how to make a movement, and especially when the movement is made passively in the arm several times, the patient is able to repeat it perfectly. These are then apparently normal and not clumsily made *nor is it necessary for patient to control these movements with her eyes.*" (pp. 148-149. Italics mine.)

Here we have a case which on the mental side illustrates three sorts or grades of movement:

(a) The highly volitional. Because of amnesia and lack of practice (it will be recalled that for four weeks the arm was not moved) this patient had apparently entirely forgotten certain arm and hand movements. These movements were made again by means of visual sensation from, and attention to, similar movements first made by the physician and also by means of visual sensation from, and attention to, the arm itself while the movements were being made.[1]

(b) The practiced voluntary. After practice, it was observed, the patient could make these arm movements without immediate visual control. (It is, however, always necessary to remember that the arm was not completely anæsthetic.)

(c) The reflex instinctive (?) These movements ("scratching," "bracing," etc.) did not require a period of learning and practice before they could be made without imitation and visual control, but appear to have been carried over into the anæsthetic condition from the normal condition. For these the remaining kinæsthetic sensibility seems to have supplied a sufficient sensory cue for their ready performance.

F. Müller describes a case of right-sided anæsthesia so nearly total that the patient could not distinguish passive movements

[1]Another instructive case has been kindly supplied me by Dr. Fairbanks of N., Mass. The patient, a young woman who suffered from spinal meningitis when ten years old, has lost sensibility in the fingers of both hands and cannot do anything with her fingers unless she can see what it is; for example, she can button or hook a garment that opens in front but not one that opens in the back. She can put her hat pins in if she is in front of a mirror. After anæsthesia appeared (which was not until about fifteen years of age) the attending physician recommended horseback riding, but this had to be given up because the patient could not hold the reins unless they were constantly kept in the field of vision. This case is particularly significant, because there are no other complicating disturbances, the patient being in all other respects highly efficient.

except when very intense. "Die aktive Bewegung der Hand und der Finger war nicht vollkommen aufgehoben aber ungeschickt, alle feineren Bewegungen waren unmöglich." (p. 403, Ueber Störungen der Sensibilität bei Erkrankungen des Gehirn, Klinischer Vorträge, Serie XIV, Heft 4-5, pp. 337-451.) In this case, too, visual sensations from the fingers were necessary for use of the finer muscles. But the significant thing in this case is that while at the end of two years the patient (an intelligent person) could not tell the position of his arm with eyes closed, he had nevertheless learned to use his hand with some facility.

The case cited in the note above (anæsthetic for 15 years) tends to show that when the anæsthesia is total no amount of practice will bring back control of the finer muscles without visual sensations from the member. The cases of Müller and Hoppe also tend to show that when local sensibility is still present, though so reduced that vision must be employed for a long time, a slow process of training under visual control may again re-establish control without visual sensations. This is well shown by Goldscheider in his "Anleitung zur Uebungs-Behandlung der Ataxie" in which he gives in great detail many devices for the re-establishment of walking and of hand and arm control, ultimately without visual guidance. It appears, however, from Goldscheider's account that there is strong presumptive evidence that none of the cases succeeding without visual assistance are totally anæsthetic. The fact seems to be that in cases successfully treated there is a modicum of sensation left which attention gradually gets hold of, and thus gradually regains control.

(4) Summary and Conclusion. The study of the proportion of sensory and motor fibres in the higher vertebrates including man shows not only a great preponderance of sensory fibres in general, but also a rich supply of sensory fibres to the voluntary muscles. The curves giving the distribution of the number of sensory and motor fibres, for the ventral and dorsal spinal roots show clearly that in a general way at least there is a marked increase in the number of sensory fibres supplied to regions whose muscles are most used in controlled activity.

Correlated with these facts are the studies of animal activity tending to show, in some instances by a process of elimination, that the kinæsthetic processes play an important part, if not a predominant rôle in the controlled activities of lower animals. Sherrington appears to refine upon this position somewhat by holding that those sensations giving the location of the member are *the* essential ones. He says: "It is found that kinæsthetic sensations of the movement to be acquired or controlled, though helpful, are less important than the resi-

dent sensations from the part in its 'resting' state. These latter, with the power to focus attention upon them, appear to be a most necessary condition for the acquirement of control. And in the monkey, voluntary control of a limb is largely lost when the limb has been rendered apæsthetic." (The Integrative Action of the Nervous System. p. 390.) Other physiological experiments support the same thesis. Munk's experiments tend to show, however, that in case of the monkey after loss of kinæsthetic sensibility there may be a process of relearning under guidance of vision.

Practically all the pathological cases that have been reviewed, tend to support the interpretaton of Munk that the kinæsthetic motor arc is not the only one whereby voluntary control is effected.

Lastly, the anatomical facts, the physiological experiments and all the cases of complete kinæsthetic anæsthesia tend to show that voluntary movement, like all other forms of movement, rests upon the existence of a sensory-motor arc; that *without sense processes relevant to the situation*, purely ideational processes, however important they may be as elements in the total mental complex functional in volitional acts, are nevertheless by themselves entirely incompetent to initiate and control such acts. Of all the mental processes that *may* function in consciously controlled acts the *sine qua non* appears to be *sensation*.[1] The facts presented show not only the necessity of centripetal impulses, but the necessity of *sensation*, at least in all forms of voluntary activity not thoroughly practiced and habitual. The relearning under the guidance of vision of lost movements on the part of Munk's monkeys, the cases of Müller, Hoppe, Spiller and Fairbanks, together with the methods used by Goldscheider and others, illustrate this abundantly. Centrifugal processes are of course necessary, but in and of themselves not sufficient. Some of the cases show that even a modicum of sensation from the member to be moved is not sufficient for control and must be supplemented by vision. The fact seems to be that there must be a sufficient amount of sensation to give rise to at least a peripheral consciousness of the member, which so far as the centripetal process is concerned is capable of becoming focal and perceptual at any moment.

IV. The General Theory of Voluntary Movement.

That psychology is in need of a more exactly defined terminology must be evident to every thoughtful reader of its

[1] By this term is meant a *conscious, but not necessarily a focal* process.

literature, particularly of that bearing upon movement and the affective processes. There is, however, another sense in which the psychology of movement is in need of a definition. It needs a descriptive and analytical definition of the various kinds and grades of movement as a basis upon which the completer analysis of the processes themselves may proceed. Of course no definition can be *a priori*, but after a certain degree of analysis has been reached it becomes imperative for further work. That the psychology of movement is in need of such a descriptive definition becomes apparent when we consider the processes in terms of which some of the standard discussions describe voluntary action.

Stout tells us that "a volition is a desire qualified and defined by the judgment that, so far as in us lies, we shall bring about the attainment of the desired end." (Voluntary Action, *Mind*, N. S., Vol. 5, p. 356.) He goes on to say, "When attainment is judged impossible, volition in the full sense cannot exist." (*Ibid.*, p. 356.) "In a perfect volition, opposing impulses are not merely held in check; they are driven out of the field. If they continue to exist they do so as external obstacles to a volition already formed. They are no longer motives. They are on the same footing with any other difficulty in the way of attainment." (*Ibid.*, p. 357.) His general position is that "it is the *cognitive* side of our nature which gives determinate character to the conative." (*Ibid.*, *p.* 356.)

It will be seen that Stout's definitive statements are quite opposite to Wundt's who holds that volitional processes are essentially always *affective* processes (Affecte) (Phys. Psy., 5th ed., Vol. III, p. 244). These feeling processes (Gefühlsvorläufe) are, however, always bound up with a more or less clear sensation or ideational process (*Ibid.*, p. 242). But the primal necessity for a volitional process is an impulsion of some sort or "so-called motive." (*Ibid.*, p. 243.) Still another characteristic of a voluntary act according to Wundt is its duration; it is "never a momentary act," but has a characteristic duration in which there takes place a change of feeling. (*Ibid.*, p. 243.) So nearly alike are volitional and affective processes in Wundt's descriptive definition that in their beginning stages it is impossible to distinguish between affective and volitional activities. The distinction appears only later in the "*Endstadium*" and is to be found in the peculiarly sudden release or change of the affective processes. It must, however, be remembered (and this is important for our own description) that the 'release process' or "*Endstadium*" involves also accompanying ideational processes. (*Ibid.*, p. 245.)

Külpe (Outlines, pp. 265-267) does essentially the same thing, making his brief analysis of voluntary movement fall

within his discussion of the Feelings. He explicitly denies the existence of an "elementary quality" as the distinguishing characteristic of voluntary action and holds that effort is the "one definite phenomenon" which fundamentally characterizes such action. This effort, he goes on to say, "appears to be a complex of more or less vivid organic sensations, composed of tendinous (strain) and articular sensations, peripherally and centrally excited." Külpe dismisses the subject with a brief general description and nowhere tells us in precisely what sense he is using the term voluntary or what the distinguishing marks of the act are, other than that it is markedly the feeling of effort which is a complex of organic sensations. But, as Stout has pointed out, the feeling of effort may "belong as well to the antagonistic tendency which renders the voluntary attitude abortive." (Voluntary Action, *Mind*, N. S., Vol. 5, p. 354.) Moreover the feeling of effort when reduced to the elements of organic sensations is theoretically hardly to be distinguished from emotion when the latter is reduced to its elements, at least according to the prevailing "peripheral" theory. The concept of effort is too vague to be used as the distinguishing mark of voluntary action. Any attempt at complete analysis of the mental processes concerned in voluntary movement is bound to find itself occupied with the cognitive aspects of these processes. It may be urged that this is an objection based upon mere convenience. Even if this were true, it would appear justifiable. Science must everywhere push its analysis in terms of that which most readily lends itself to analysis, provided always, of course, that the analysis does not proceed at the expense of truth and completeness.

The objections urged against the feeling of effort in particular hold also with reference to the feelings in general as distinguishing features in terms of which to analyze and describe our voluntary activities. Against the description of voluntary movement in terms of feeling the following arguments are urged: (1.) Feeling is never the fundamental process in a complex and highly voluntary activity. *Functionally* it is of great importance as a part or aspect of the motive in every voluntary movement from the simple impulse to the volitional act. But, as Titchener has clearly pointed out, the motive is complex, made up of sense or ideational processes on the one hand and affective or feeling processes on the other. But—and this is the important point—the sense or ideational process is always the *conditioning* process, *i. e.*, its nature and meaning always determine the nature and intensity of the feeling.

(2.) Biologically considered the feeling as a psychic process, functional in a controlled response, is entirely too subjective, too vague, too little informational to be regarded as the fun-

damental process in effecting voluntary control. The fundamental process is the one that best reveals the situation to which the response is made. For this reason the term "cognitive" is significantly appropriate to the sense and ideational factors. They reveal the situation and so afford a basis for successful reaction. Organic sensations at best tell us only of the subjective; but voluntary movement, in the last analysis, finds its cues and control factors (not necessarily its entire motivation) in external conditions. One might even go so far as to say that every movement that takes place wholly on the basis of the subjective and without any regard to objective or extrabodily conditions of a sensory or ideational nature is essentially of the reflex or automatic type.

(3.) Common observation teaches also that the predominance of purely subjective elements is always an interference in volitional performances. Feeling doubtless plays a highly important function in the *initiation* of many voluntary activities but the position taken here is that *voluntary movement is not a matter of initiation of movement nor a peculiar species of movement per se, but is essentially a form of control and in this respect alone differs primarily from other kinds of movement.* So far then as voluntary acts are concerned, the initiation of movement may be assumed; it is provided by the physical and mental constitution of the organism which, in the psychology of the individual, must be assumed. Biologically voluntary movement is a peculiarly *individual* form of adaptive control. Perhaps it would be better to say that it is peculiarly individual just because it is adaptive to conditions that are nonracial and therefore individual. Psychologically voluntary movement is a kind of movement in which sensory or ideational processes are *necessarily* functionally present. All nonvoluntary movements are therefore to be defined in biological or physiological terms; in them sensory or ideational processes are unnecessary for their efficient execution. Practiced and habitual movements, or such as are only partially racial, are, on the other hand, movements in which psychical processes are still required at critical points. Many of our instincts and practically all of our common habits belong to this grade. But whenever an instinct or a habit is for any reason lifted temporarily to the higher volitional level, it is always with an increase in clearness and definiteness of the accompanying *cognitive* processes that this is accomplished. In case of the instincts the increased clearness, together with perhaps an increased complexity, of the cognitive elements is precisely what makes the instinct a voluntary activity. Or, to state it in another way, the instinct becomes voluntary directly as the cognitive processes gain in clearness.

We should say, therefore, that instead of voluntary movement being a feeling modified by a judgment, it is rather a complex process in which a feeling reinforces the motor aspect of the focal or cognitive elements. The position here taken is that, whatever may be true in other forms of conscious states, for voluntary movement so long as feeling predominates consciousness, that is so long as the cognitive elements are submerged or "swamped"—to use Titchener's phrase—there is no *voluntary* movement; that voluntary movement can begin only with the appearance of distinct cognition or at least distinct sensation, and that with the "swamping" of the latter there goes also the disappearance of voluntary movement. It is contended that *voluntary movement means control and that control in turn means cognition.*

(4.) To this interpretation the physiological experiments of Mott and Sherrington and Munk together with the pathological cases already reviewed lend strong support. They tend to show that all movement above the reflex level requires *sensation* for its execution. They tend to show, too, that a feeling, desire to move, or *Gemüthebewegung*, without the cognitive process, is entirely incapable of controlling the movement. Certain of the cases of anæsthesia show that there are conditions when "inner" volition, or desire to make a movement, is entirely possible without the ability to make the movement, *not because it is physiologically impossible but because it is psychically impossible* for the reason that indispensable cognitive data are wanting. It follows therefore that all movement taking place while feeling is dominating consciousness is of the reflex-instinctive type; that under such conscious conditions voluntary movement is only partially, and perhaps not at all, possible; that control (the essence of voluntary movement), demands at least two things, awareness of the position of the member to be moved and consciousness of the current results of the movement.

(5.) Once more, voluntary movement necessitates voluntary or controlled attention. In fact, so close is the relation between voluntary movement and attention that if one neglects the *nature* of the processes, voluntary movement may be accounted for wholly in terms of attention. But upon what material does attention naturally operate, upon the feelings or upon the sensory and ideational processes? By what may perhaps be properly called a process of selection attention goes to those processes which by being rendered focal and clear will most facilitate control. Here, again, we have evidence for the primacy of the cognitive processes.

Voluntary movement is peculiarly psychical and therefore as a *kind* of movement almost wholly a psychological prob-

lem. Physiologically it is not a new form of movement bringing into play necessarily a new coördination. Looked at as an activity of a muscular mechanism it is highly probable that new coördinations never take rise in voluntary movement. What is new is the making of these muscular coördinations in response to psychical conditions rather than in response to purely neural and physiological conditions. In short, it is a new *control* rather than a new muscular coördination; or, to put the matter in another way, it is a new chaining together of coördinations which in themselves are old. The reflexes and the instincts supply all the neuro-muscular pathways. When these pathways are utilized under individual conditions, instead of old and racial conditions, we have voluntary movement.

It follows from what has been said that all movement as such begins as a purely physiological process; that, at least so far as the individual is concerned, the reflex or impulse is the prototype of all action. This appears so evident as to call for no detailed discussion.

A second consequence of the view here presented is that the earliest movement-consciousness is in no sense the cause of the movement, but only a by-product of a complex psychophysical mechanism, the physical aspect of which becomes operative before the mental. Experimental evidence for this is found in the studies of Bair and Woodworth, who demonstrated that there is consciousness of a single movement taking place in a larger complex movement before there is ability to control that movement in isolation. We are at times apparently conscious of our reflexes without at the same time being conscious of any control over them whatsoever. This is particularly true of instinctive behavior of the reflex type. In fact it is very probable that at any moment our conscious life is wider than its functional aspects, that in the most voluntary activities the functional processes are never coextensive and identical with the conscious processes. The functional processes never make their first appearance as such, but appear as epiphenomena and then, after they are picked out of the total conscious complex by attention, become controlling factors. In support of this point also the work of Bair affords evidence. The learning of complicated activities, in so far as they are consciously, or voluntarily, learned, like riding a bicycle, etc., illustrates the same general truth. The correct movement is reflexly made, or accidentally hit upon, under guidance of the general intention, as a consequence of excess stimulation. Certain sense elements connected with this movement are then caught by attention. These elements then become functional by virtue of the effect of attention. The

supporter of the kinæsthetic theory may contend that it is impossible to conceive how control can *begin*, except the results of the movement previously made in a reflex manner are first *imaged*. This is the position taken by James when he says: "In the chapter on the Will we shall learn that movements themselves are results of images coming before the mind, images sometimes of feelings in the moving part, sometimes of the movement's effects on eye and ear, and sometimes (if the movement be originally reflex or instinctive), of its natural stimulus or exciting cause." (Prin. of Psy., Vol. I, p. 445.) Our own position is a refinement of that set forth by James. We contend, first, that the perception or image "of its natural stimulus or exciting cause" is always sufficient to *initiate* the movement once it has been learned or practiced and that the *control* is effected by *immediate* sensations and perceptions and not by memory images of previous results. We contend further that in the period of learning or practice the process is not one in which memory images "resident or remote" play the primary rôle, but that it is on the other hand primarily a process of varied inhibition and re-enforcement, based on the perception of results, this perception being either of a kinæsthetic nature or of a visual or auditory nature, depending upon the nature of the movement and probably also upon the hereditary and acquired nature of the individual.

At this point the function of feeling in voluntary movement is apparent. The inhibition and re-enforcement are in each instance very largely due to the feeling aroused by the perception of the result. Let it be observed, however, that in each case the nature of the feeling is determined by the nature of the cognitive process.

While the purely ideational processes are of considerable importance in initiating movement and of slight importance in its control the conditions with regard to the sensory processes are reversed. Movements initiated by purely sensory processes are rarely if ever voluntary. On the other hand movements originally initiated by purely ideational processes are rarely, if ever, other than voluntary. This is only natural. Ideational processes are racially recent and novel; they are not provided with a mechanism of preformed pathways by means of which expression and control quickly become coördinated and exact. "All consciousness is motor," but not equally so, nor with equal definiteness of expression. The sensory processes are both more motor in tendency and more definite in reaction. Ideational processes, so to speak, lack a mechanism of their own. As elements in movement they have come into an organism built upon a sensory-motor basis. They have come into what Morgan has called a "going concern" and therefore as factors

in voluntary action must make use of a mechanism that is essentially sensory-motor and non-voluntary. So far then as the initiation of voluntary movement is concerned, this means a readaptation of the mechanism for ideational ends. Ideational processes are therefore necessarily present in the original initiation of voluntary movement.

So long as a purely sensory content is sufficient as a cue to adaptive movement, just so long there is a preformed sensory-motor mechanism provided for the execution of the corresponding movement. In short, there is a mechanical or "uncontrolled" response only when there is a mechanical reception of the stimulus or situation. That is, given conscious meaning in the *psychical* response, there is bound to be *control* in the *movement* response. But conscious meaning always implies the presence of ideational processes. We therefore conclude that whenever ideational processes as such are the initiatory processes there is always some control in the resulting movement. This means that ideational processes are never epiphenomenal in a movement-consciousness, provided, of course, they are related to the movement. An ideational process cannot directly initiate a movement without the movement being a controlled one, at least in its earliest stage. The presence of an ideational process means a higher level of consciousness, which in passing over into bodily activity carries with it a consciousness of the control that invariably becomes an element in the control. We cannot *think* about our movements while they are taking place without in a measure controlling them from this high-level consciousness which, whenever present, is always *functionally* present. We cannot ideationally cause a wink of the eye without to a degree at least controlling the resulting wink. We cannot think about our walking while we walk without to a degree controlling it.

This does not mean that all consciously controlled movement is *originally* initiated by an ideational process. It has already been pointed out that all sorts of processes may serve as starting points for the reason that "all consciousness is motor." It means only that when an ideational process *does* start a movement the resulting movement is, at least in its initial stages, more or less consciously controlled. But if a movement started as a non-volitional process, becomes a controlled activity, *it always becomes such in consequence of some sort of ideational process.* That is, so long as the initial sensorial process remains such (without meaning), there is no voluntary control. Control is never initiated except there be a psychical reason for it, and such "reason" cannot be found in a purely sensory process devoid of meaning. In other

words, the motive that leads to the initiation of voluntary control of a process capable of sustaining itself without such control must contain meaning, which is a psychic element of the higher level.

Nor is this meant to imply that the control as such is essentially carried on by ideational processes, however important these may be in bringing about the control. In matters of control ideational processes are only vicarious and supplementary, and even then their functional value may be questioned. Control is necessarily perceptual and sensory.

The theory of voluntary movement that has been here presented starts from a physiological process, and ends again with a physiological process, making psychic processes and attention middle terms in effecting a readjustment to the environment. This theory holds that the first control in learning a new movement is always gained by attention picking out certain elements, which in their first appearance are entirely non-functional.

It holds, too, that throughout the volitional or highest grade of movement, both clear imagery and clear perception are necessary for proper initiation and efficient control. It holds further that in the lower or practiced grade, in which attention leaves the process, it may do so by way of the substitution of a general symbol for the details of the original process to which attention was necessarily given at the beginning of the practice.

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AN EXPERIMENTAL STUDY OF BELIEF[1]

By T. OKABE, PH.D.

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The object of the present study is to describe, in analytical terms, the experience of Belief, as it appeared under experimental conditions. Although a good deal has been written, by psychologists, upon the subject of Belief, it is not too much to say that the status of the experience is still very uncertain, and its place in the system of psychology undetermined. A brief historical review will suffice for the support of this statement.

Perhaps the first writer to give an empirical psychological criterion of Belief is David Hume. Belief or Assent is the vivacity of the perceptions presented by memory and the senses, the force and liveliness of these perceptions; it is a strong and steady conception of any idea (*A Treatise of Human Nature*, ed. by L. A. Selby-Bigge, 1888, 86, 97 *n*, 101, 103, 116, 119); it is the manner of our conceiving ideas which bestows on them an additional force and vivacity (96). An Opinion or Belief is a lively idea related to or associated with a present impression (96, 93, 97, 98, 209, 626); the relation is due to custom (102, 626), and the Belief arises only from causation (107; *cf.* 113). The vivacity proceeding from a customary conjunction with a present impression is an ultimate character of ideas (636, 629); that of the historical narration, *e. g.*, is more forcible and real than that of poetry (631).

According to James Mill, Belief is an inseparable association. "In every instance of Belief, there is indissoluble association of the ideas . . . Cases of indissoluble association, admitted by all men to be this, and nothing more, are acknowledged as Belief" (*Analysis of the Phenomena of the Human Mind*, i., 1869, 368 f.). Here is the

[1] From the Psychological Laboratory of Cornell University.

one side of the Humian doctrine. According to John Stuart Mill, Belief is more than an inseparable association (*ibid.*, 418). "What is the difference *to our minds* between thinking of a reality, and representing to ourselves an imaginary picture? I confess that I can perceive no escape from the opinion that the distinction is ultimate and primordial. There is no more difficulty in holding it to be so, than in holding the difference between a sensation and an idea to be primordial. It seems almost another aspect of the same difference. . . . Grant these differences, and there is nothing further to explain in the phenomenon of Belief" (412 f., 419 ff.). Here is the other side of the Humian doctrine, though its statement is less concrete than in the pages of Hume himself.

Alexander Bain finds "the first germ and perennial substance" of Belief in what he terms primitive credulity: "we begin by believing everything; whatever is, is true." "We may, if we please, call it an impotence of thought; for, without some positive interference from without, there is no other way of doing or thinking." Belief as a specific experience "is distinguished when we suffer the shock of a contradiction, a check or disappointment in some career of activity." This Belief, an "innate credulity tempered by checks," is influenced by various factors, intellectual, emotional and active. Logically, it is opposed to disbelief; "but as a mental fact these two states are identical . . . The real opposite of Belief as a state of mind is not disbelief, but doubt, uncertainty." What precisely "the state of mind called Belief, expectation, confidence, trust, assurance, conviction" is, in psychological terms, Bain does not tell us; it involves intellect, but knowledge is not the whole of it; it is often accompanied by strong emotion, yet emotion does not amount to believing. Since "preparedness to act upon what we affirm is admitted on all hands to be the sole, the genuine, the unmistakable criterion of Belief," it is clear that Belief is a mode of will; it has its germ, as we have seen, in the primitive tendency to accept whatever has not yet been contradicted; at the same time, the working of this primordial impulse would not of itself have led to any mention or differentiation of Belief; there is a necessary intellectual element,—some cognisance of the order of nature, or of the course of the world. In a word, Bain gives us a genetic account of Belief, tracing its sources, constituents and dependences in general terms; but he does not offer us an analysis of the actual experience of Belief (*The Emotions and the Will*, 1880, 505 ff.). The most important features of this account are, first, the insistence on the naturalness or nativeness of Belief, the mind's instinctive tendency to accept, so that the thing to be explained in psychology is rather doubt or obstructed belief than Belief itself; and, secondly, the couching of a theory of Belief in 'motor' terms. These two features do not appear to be necessarily connected.

Herbert Spencer follows James Mill in reducing Belief to an indissoluble association (*Principles of Psychology*, i., 1881, 421; ii., 406 ff., 505*hh-ii*). Franz Brentano, on the other hand, accepts and recasts the doctrine of John Mill. "Nach unserer Ausdrucksweise ist seine Lehre die, dass Vorstellen und Urtheilen zwei völlig verschiedene Arten der Beziehung auf einen Inhalt, zwei grundverschiedene Weisen des Bewusstseins von einem Gegenstande seien" (*Psychologie vom empirischen Standpunkte*, i., 1874, 275). Neither of these authors helps us towards a psychological analysis.

So far we have found Belief described as an elementary process or function of mind, and as a complex intellectual or volitional formation. The affective interpretation has not either been wanting. It

has, indeed, been ascribed to Hume himself, on the basis of the following passage: "The difference between fiction and Belief lies in some sentiment or feeling, which is annexed to the latter, not to the former" (*An Enquiry Concerning Human Understanding*, Religion of Science Library, 1900, 48). It is clear, however, from other passages, that Hume's doctrine of Belief in the *Enquiry* is in substance identical with that of the *Treatise:* what characterises Belief is not so much a 'feeling' as a 'feel' (48 ff., 112; *cf.* W. B. Elkin, *Hume*, 1904, 172 ff.). W. James, on the other hand, declares that "in its inner nature Belief, or the sense of reality, is a sort of feeling more allied to the emotions than to anything else;" "Belief consists in an emotional reaction of the entire man on an object." At the same time, he thinks that it resists further analysis: "Belief, the sense of reality, feels like itself—that is about as much as we can say;" "this attitude is a state of consciousness *sui generis*, about which nothing more can be said in the way of internal analysis." James agrees with Bain that the true opposites of Belief, psychologically considered, are doubt and inquiry, not disbelief, and that the primitive impulse is to affirm immediately the reality of all that is conceived. He agrees, also, that Belief is closely connected with motor activity: "motor effects are apt to follow;" "consent and Belief are both intimately connected with subsequent practical activity" (*Principles of Psychology*, ii., 1890, 283 ff.). We need not here follow James into his discussion of the conditions of Belief. We note that W. Bagehot speaks explicitly of Belief as an emotion, the emotion of conviction (*Literary Studies*, i., 1879, 412 ff.).

Three other modern psychologists—J. Sully, J. M. Baldwin, G. F. Stout—call for mention in this connection. According to Sully, Belief is a compound of three factors: intellectual representation, feeling, and active impulse. Intellectually regarded, Belief "marks off the objective attitude of ideation or thought, or, in other words, the fact of its representativeness." Affectively regarded, Belief is "the state or feeling of restful assurance, which is always present in some degree when we judge or decide upon a matter, and which gives to our judgment its characteristic psychical coloring." Again, Belief stands in organic connection with action; Belief and activity react the one upon the other. "In most cases, at any rate, Belief involves the incipient excitation of impulses to look out for a result, and to follow a line of action" (*The Human Mind*, i., 1892, 453 f., 483 ff.; ii., 276 ff.; *Sensation and Intuition*, 1880, 75 ff.).

Belief, as a specific mental state or process, is treated by Baldwin in his *Handbook of Psychology*, ii., 1891, *Feeling and Will*. "The feeling of Belief is a feeling which attaches to the representative faculty primarily." "It is a feeling of confirmation and security over and above the feeling of simple reality;" "Belief in anything is the consciousness of the presence of that thing as fitted to satisfy a need; and it is distinguished from the earlier unreflecting reality-feeling, which is the simple consciousness of a presence;" Belief is "a feeling arising from the successful outgo of impulse." Baldwin regards this feeling as *sui generis:* "as a feeling, Belief cannot be explained any more than any other feeling; it must be felt; further remarks are really upon the physiological and psychical conditions under which this feeling arises" (155 ff.).

Stout uses the term Belief in a wide sense as interchangeable with judgment, and regards it as an attitude of consciousness towards its object, fundamentally distinct from simple apprehension; in this position he follows Brentano (*Analytic Psychology*, i., 1896, 96 ff., 115; ii., 234 ff.).

In Titchener's *Outline of Psychology*, 1896, 315 f., Belief is given a place among the intellectual sentiments, and a method of investigation is proposed. The passage runs as follows:

> "The intellectual sentiments might be investigated in the following way. Prepare a number of reasoned statements—or select them from the lists given in the text-books of formal logic—some of which are correct, while others contain various logical fallacies. Let the subject give a careful introspective account of the 'feelings' aroused by their reading. . . . A rough notion of the number and forms of the intellectual sentiments can be obtained by introspection of consciousness during the reading of a piece of scientific reasoning, or the hearing of a scientific lecture."

Here is evidently a suggestion of the experimental method which has recently been widely used in the investigation of the processes of thought. We ourselves employed the method in two forms: as a method of single exposures, and as a method of paired comparisons. We prepared a long list of sentences, with a view to the arousal, in the mind of the observer, of belief, disbelief or doubt; the sentences were made as short as possible, in order to avoid unnecessary complications in understanding, and were selected with an eye to the interests and attainments of the observers. Series were also taken in which the sentences were replaced by mathematical expressions. These four principal experiments will be reported separately.

A long series of preliminary observations was made by Professors Titchener and Bentley. Sentences, calculated to arouse belief or disbelief, were typewritten at the head of sheets of paper, and the observers were instructed to read with understanding, to note the appearance of belief or disbelief, and if either of these consciousnesses occurred to write a full introspective account of the experience. No limit of time was set for the understanding, and no record was taken of the time required for the appearance of belief or disbelief; the object of the observations was a purely qualitative analysis. The tests showed, in general, that there is a definite consciousness which is unhesitatingly recognised and named as belief or disbelief, and is distinguished from mere assent, or passive acceptance, but that this consciousness is of comparatively rare occurrence. It was surprising, both to the experimenter and to the observers, that sentences which seemed likely to arouse a strong response, of belief or disbelief, were taken coolly and passively; the observers were 'ready' to believe, knew that the analysis of belief was the 'problem' before them, and nevertheless found, in the great majority of cases, that the sentences were accepted or dismissed as if automatically, or that they were met with an indifferent suspense of judgment. We may say at once that a like difficulty,

though of less degree, was encountered in all the regular observations. It may, no doubt, be ascribed in good part to the nature of the stimuli employed,—detached sentences, laid before the observers apart from any context or cumulative argument. At the same time, if casual but long-continued observation by the experimenter and others may be trusted, a distinctive belief-consciousness is not of common occurrence in everyday life. This statement, however, necessarily remains vague until we have given a detailed analysis of that consciousness.

METHOD OF SINGLE EXPOSURES: SENTENCES, VISUAL

In this first series of experiments, the observer, seated comfortably at a table, was shown a typewritten statement, and was instructed to read it with concentrated attention, to note whether it aroused belief or disbelief, and on the appearance of either consciousness to close his eyes and to dictate to the experimenter a full account of the experience. In a certain number of cases the introspective record was fractionated: that is, in some observations the period covered extended only to the understanding of the sentence, in others it began with the understanding and ended with a clearly formed belief or disbelief; we have not thought it necessary, however, to give these fractionated results a separate treatment. No time records were taken. The regular observers were Miss A. de Vries (V), a graduate student in psychology; Miss H. Clarke (C), fellow in psychology; Dr. L. R. Geissler (G), instructor in psychology; and Mr. W. S. Foster (F), assistant in psychology in Cornell University. Less numerous observations were made by two other students, Mrs. Piotrowska (P) and Mr. Clarke (Cl).

It should be said that all four of the regular observers had taken part, in the previous year, in a Seminary discussion of the experimental investigation of the thought-processes. They were therefore familiar with the method employed, with its limitations and dangers, and were especially alive to the difference between informatory report and psychological description. Largely for this reason, questioning by the experimenter was ordinarily unnecessary, and was in fact very sparingly used. Recourse was had to it only when the observer was obviously reporting in verbal shorthand, and even then it was made as little suggestive as possible; in particular, no hint was given that certain processes were wanted or expected by the experimenter, and no limit was set to the observer's vocabulary. There was, of course, a good deal of *Kundgabe* in the records at large, and we were content to let it stand as such; only as regards the consciousness of Belief

proper were we at great pains to translate the *Kundgabe*, where it occurred, into *Beschreibung*. Belief and disbelief were, as has been said, the strict topic of our analytical inquiry.

In order to deal effectively with the great bulk of introspective material, we take up the observers in order, give a brief characterisation of their mental constitution, and then state the results of their analysis. Selections from the introspective records are appended as evidence. The numbers prefixed to the general statements correspond to those prefixed, later, to the selected introspections. Samples of the sentences employed will be found at the end of this paper.

Observer V

With this observer we made 196 successful tests. *V* is of an impartially imaginal type, (1) and is especially liable to empathic kinæsthesis, sensory and imaginal. It is interesting, as an item of individual psychology, that verbal images were of comparatively rare occurrence, and that they occurred always with disbelief, never with belief. Belief and disbelief are characterised by a fairly intensive affective process, (2) which is almost always pleasant; the pleasantness appears as well with disbelief as with belief. The most important and characteristic factor in the belief-disbelief consciousness was an organic (mainly kinæsthetic) complex, which stood out clearly and sharply from the other contents of the moment. (3*a*) Slowing and deepening of breathing, with attendant change of sensation, were frequently reported. There were also (3*b*) kinæsthetic sensations from a shift of bodily attitude, from sitting up and straightening in the chair. With strong belief or disbelief there was (3*c*) a 'feeling of power' or 'feeling of superiority;' the whole body felt as if stiffened into something massive and strong.

V had a personal interest in the experiments, and took the 'problem' very seriously. Possibly for this reason she showed a type of reaction which was not found with the other observers; (4) as soon as the sentence was read, there was a belief-disbelief consciousness of an indefinite kind; then the sentence was re-read, with a view to complete understanding, or to verification of the previous understanding; and then, finally, belief-disbelief emerged in definite form, and in stronger or weaker degree as the case might be. When the decision had been taken, and belief or disbelief established, (5) the aggressive attitude changed to a relaxation of muscular strain, with the emotion of relief.

(1) A 131. Imaginary image of a Chinese in the water. Felt choked, as if I were drowning. A 126. Visual image of a trick ele-

phant dancing. Felt big and clumsy myself, as if I were the elephant.

(2) A 59. Decided I did not believe it. Pleasant. A 81. There was no hesitation about understanding it and coming to this conclusion. Pleasant. A 58. Rejected the whole statement as unsafe. Don't believe it. Decisive. Pleasant. A 125. The feeling of disbelief was definite, clear, like a streak of yellow color or the call of a trumpet. Felt pleasant. A 60. Decided in an instant that I disbelieved it. Pleasant. A 102. Verbal saying over to myself: Of course don't believe it. Satisfaction. A 11. The feeling that I was right in not believing it . . was pleasant. A 88. Clear verbal ideas: There's something wrong; it isn't a good comparison. That was pleasant.

(3*a*) A 3. Believed it. . . Sensations from deep breathing. A 10. Sensations from slow breathing. . . Believed it. A 125. Felt strong, and sensations from deep breathing. (Disbelief.) A 58. Sensation from sitting up, and long breathing. (Disbelief.)

(3*b*) A 60. Straightened up. (Disbelief.) A 11. Sensations from frowning and sitting up; felt tightening of jaw and strain of arms. Disagreed with everything in the statement. A 17. Sensations from straightening up, and I knew I did not believe it. A 56. Belief strengthened the more I read it. Felt sure I was right. Sensations from sitting up straight.

(3*c*) A 11. Felt aggressive. (Disbelief.) A 58, A 125, etc. Felt strong. A 12. Knew I believed it. Felt satisfied and rather superior, as if my decision were surely right. A 29. Belief came suddenly and was certain. Felt I was right in believing it. Pleasant, and felt strong and cool. A 32. Believed this part. Pleasant, and warm sensations up and down the spine. Rejected all the rest as a mass of useless words. Felt superior.

(4) A 77. Read and understood; did not believe it. [Then follows a stage of thought, given mainly in attitudinal terms.] Then I knew why I disbelieved the sentence, and felt satisfied. A 7. Read sentence and had clear auditory after-images. Decided at once that I believed it. This was very pleasant. [Then follows a stage of doubt and deliberation.] Decided I had been right in believing it. Felt pleasant. A 24. Read it once and knew I would never believe it. [Then follows a stage of consideration.] Felt superior; sensations of straightening up and of deep breathing; sensations also from skin of face around the mouth. Then rejected the whole thing at once.

(5) A 7. Muscles all relaxed. A 21. Felt relaxation when I decided. A 60. Felt relief. A 1. This I do believe, and when this was decided I relaxed. A 10. Relaxed all over. A 11. At the end, my muscles were all relaxed and I sighed in relief. A 12. As I became sure I had kinæsthetic sensations from nodding, and relaxed.

Observer C

With this observer we made 218 successful tests. *C* is an excellent visualiser, and less impartial in type than *V*. (1) Almost all her reports contained descriptions of visual imagery, sometimes vague and schematic, sometimes sharp and clear. (2) The reaction of belief-disbelief was usually affective; but the affective processes were less intensive than for *V*, and were often qualified by a 'rather' or 'slightly.' With very few exceptions, the experience of belief was pleasant, that of disbelief

unpleasant. (3) Organic sensations were seldom reported, and were not intensive. (4) The most important and characteristic factor in the belief-disbelief consciousness was a 'perception' of agreement or disagreement, of harmony or disharmony, which was difficult to analyse, but seemed in every case to be preponderantly visual. (5) This 'perception' was clinched and expressed in verbal form; with belief came the verbal ideas 'Yes,' 'That is true,' etc., and with disbelief the verbal ideas 'No,' 'It is n't true,' etc. Internal speech, overt or abbreviated, was very common.

(1) A 59. Meaning was perfectly clear and was illustrated at every step by what might be called symbolic visual images. The whole thought was thus objectified. E 1. The word natural was attended by the visual image of the outside of Max Müller's book on Natural Religion. . . In connection with first part of sentence, visual image of a savage on the seashore. . . There was also a schematic representation of a savage as related to other members of his society. This was mostly a matter of geometrical lines with the savage himself in an angle, and was too vague to be definitely described. E 2. Very clear visual images of the whole incident described. Saw the child in the schoolroom, even having a vague idea of his place in the room, and followed him to the store which was definitely located in reference to the room. . . There was also an image of the man who answered at the other end of the telephone. A 129. Visual image of a page of Spencer's Data of Ethics with the paragraph marks which he uses. E 9. An imaginative image of the infant being brought into the room and the change of expression in his face. Then memory images of babies I have known, especially one. . . The image of the real baby changed somewhat to agree with my memory of him at different times, and was set upon a sort of dissolving background, now his own home, now a room in his grandmother's house. The latter was quite distinct and definite. There was a background to the imaginative images too, a room, part of which I could describe rather definitely. Here, however, there was no tendency to change; the image was about as static as a visual perception and remains so yet.

(2) A 11. Assent was accompanied by a feeling of pleasure. A 7. The assent in this case was accompanied by an agreeable feeling, what might be called a feeling of satisfaction. A 12. The assent was accompanied by a pleasurable feeling and amusement. A 56. I assented to the proposition and the feeling was slightly agreeable. E 3. Disbelief. . . Attitude of dissatisfaction.

(3) E 3. Negation at every step accompanied by unpleasantly unsettled organic sensations. A 59. Feeling of strain in the eyes and holding the breath. [Reports of this degree of definiteness were very rare.]

(4) E 9. Conscious attitude of lack of agreement with my experience. I don't know what this was. It was a certain visual blankness in part; I found no corresponding fact in my experience. E 6. Visual images of Rousseau as I have always imagined him, not as he looks in his picture. Visual image of several people in a wood, representing my idea of Rousseau's return to nature. These were both imaginative images originally, but have long represented these ideas to me, and are in a sense memory images now. I was aware that the statement agreed with what I knew of Rousseau. It is hard to tell what this agreement was; it seemed to lie in the images. E 5. Visual image of

the outside of a book that I once read on a related subject. Schematic representation of opinions that I have read or held about the question. I seemed to see a long and broad trench about as wide as a street, and the opinions were in some way localised there. A consciousness of agreement between them and the sentence; this seemed to belong to the visual representation of them. E 11. Visual image of one of Max Müller's books with his name on the outside. A series of visual images that represented his theory to me when I first read it. Feeling of amusement at the incongruity of the statement just read with the general trend of Max Müller's theories. Then a very distinct image of people inventing language through action, as I perceived it when read. Idea, vaguely verbal, that there was less contradiction here. There was more in this than words. I think the two ideas seemed spatially closer than in the other case, though only one of them was represented by a distinct image.

(5) E 1. Verbal image: This is only relative. E 2. Verbal image: It may be true. E 4. Verbal image: Imageless thought. E 7. Verbal image: Of course a deaf-mute has concepts. A 12. I said: Yes, especially from the standpoint of structural psychology. E 3. Verbal image: Not every one. E 9. Verbal image: May be true; I don't know. A 129. Verbal images: Believe Spencer said it; not so sure it's true. A 22. Said: I don't know; and then: Probable. A 59. Said the word Analogy. . . Gave a partial assent in the words: It is probable.

Observer G

With this observer we made 170 successful tests. *G* may be characterised as of the verbal-imageless type; in his ordinary thinking he makes no use of visual images, and though he is a skilled musician he has no mental furniture of auditory images; he thinks, if the phrase may be coined, in verbal awarenesses. Our own experiments, as well as other and similar experiments in which he has recently taken part, prove that he has, at least in some degree, the capacity for images, visual and auditory; "the assimilation of a new idea, or the understanding of a novel term, is for *G* a definitely imaginal experience, but with growing familiarity the images very quickly lapse."[1] We find, in fact, (1) that *G* occasionally reports imagery, though in this matter his introspections, as a whole, are in marked contrast to those of *V* and *C*. Almost invariably (2) he reports internal speech: sometimes in the form of properly formulated sentences, usually in what *G* terms 'shorthand,' a more or less abbreviated and schematic representation.[2] The verbal images Yes, No, and Nonsense were the commonest. (3) Organic sensations are not a marked feature of *G*'s consciousness. (4)

[1] Titchener: Experimental Psychology of the Thought-processes, 1909, 248.

[2] The verbal shorthand consisted, in general, of an intermittent pressure of the tongue against the palate, and of the setting of the organs of speech for the articulation of initial consonants. *G* will publish, in another place, a full introspective account of this mode of verbal ideation.

He is, throughout this series of experiments, reluctant to identify belief either with verbal imagery or with kinæsthesis; he seeks to give it a formal explanation, as an Herbartian apperception, or a Wundtian assimilation; he speaks of the 'fusion' of the statement with memory ideas, and of a 'conflict of meanings'; yet he fails to find any conscious contents aside from the words and the kinæsthesis; belief is beaten up with these experiences, as in the case of *C* it is with the visual images. (5) The affective side of the experience is fairly strong; with a few exceptions, which can be explained, belief is pleasant and disbelief unpleasant. While, as we have said, belief was not attended by any pronounced kinæsthetic or other organic complex, the presence of muscular tension is shown (6) by the frequent report of an emotion of relief after assent has been given or withheld.

(1) A 5. At the same time vague memory idea, illustrating this principle, of an automobile localised in vague visual terms in front of the Armory, where I frequently have seen them backing up or trying to turn round. I don't know why I should call these images visual, because I don't see anything, but somehow, whether by habit or imitation, I refer them to some strain in the muscles of the eyeball. Anyhow, the images are so vague that they might just as well be entirely kinæsthetic.[1] A 126. Vague visual image, when I closed my eyes, of a gray mass, vaguely of the shape of an elephant, and then another visual image, a triangular shaped, whitish image corresponding to a circus tent. A 90. Visually, in very vague images, I saw myself in the Acoustics Room, where all my experiments have been done. A 9. The word 'expression' was accompanied by a visual image of a picture of an actress, seen in my room just before I left the house. A 87. I had vague image of Professor Titchener in the Seminary Room and of his situation, and vague auditory image of his voice. A 10. Very vague and indefinite picture of battle with soldiers charging and getting wounded. Now attention seemed directed to man lying wounded in the foreground. . . Now a man slightly wounded arose and began to attack.

(2) A 114. My reaction towards this statement was mostly in verbal form; I had a strong muscular tendency to say aloud: Oh, that is nonsense. The words: Oh, nonsense, are one of my habitual reactions to statements that strike me as absurd. A 116. In more or less abbreviated verbal form the question arose in me: How can movement direct the trend of thought? . . The words: strain, attitude, kinæsthetics, sounded in my ears. A 58. The refusal to accept was accompanied by motor tendency to habitual expression: Aha! A 101. While visually reading there was verbal comment in the background. This consisted in slight innervations of the throat and back of the mouth for the expressions What is that? That is absurd, Nonsense, No. A 77. Had abbreviated verbal comment, which if written out would be: Intelligent persons are not always white men, and more pressure does not mean more power. A 126. That is disbelief, because verbal comment ran: Implies reasoning in animals, which doesn't exist. A 84. Brentano's name came up (internal speech).

[1] *Cf.* the analysis of the memory image given by C. W. Perky, this *Journal*, xxi. 1910, 450.

. . At once the thought struck me: This is a very empty phrase if you take it literally, and there is no danger of getting into trouble if you accept it: this thought was not so elaborate in consciousness, but occurred in the usual shorthand verbal fashion.—Reports of this sort are as common as those of the former sort are rare.

(3) A 101. Reread the whole statement and had a slight kinæsthetic tendency to shake my head. A 58. Empty, blank consciousness . . . was simply absence of ideas, while a slight organic or kinæsthetic background was present.—More than once *G* reports 'a tendency to smile and say: That is nonsense; the tendency to smile was mostly kinæsthetic or motor tension in the face, and especially around the eyes.' Often the report is given: 'I did not notice any kinæsthetic or organic processes.'

(4) A 3. As soon as the whole phrase fused or associated with the idea that this means, in other words, that the whole world is a total mental process, then agreement was established with a strongly pleasant relief noticeable also in the body and in change of position. In this case the attitude was markedly kinæsthetic, and not a mere association of ideas. A 78. When I got as far as the word Kicking (in reading the first time) my left foot (the left leg being crossed over the right) started more or less unconsciously a quite marked upward movement and caused a host of kinæsthetic strain and muscular sensations. This concrete example (whether merely coincidence or not) or illustration of the statement made the acceptation of its truth easy and pleasant, although as a rule I am very sceptical with regard to motor tendencies. But this concrete example convinced me quite strongly that the state of acceptation or belief is mostly a fusion of new ideas with memory ideas. In this particular case it was a fusion (or coincidence) of a new idea with a homogeneous perception. By homogeneous I mean a perception of the same content as the ideated content. A 79. Disbelief, because there is a host of verbal objections, verbally more or less articulated objections. I don't know how to describe it otherwise than as a conflict of meanings. These conflicting meanings arise already during reading, and become focal after I get through reading. I can't analyse these meanings. They attach themselves to verbal articulations. The conflict itself can't either be analysed; it is too complicated. A 19. Disbelief came especially in the word: Meek. There was a conflict. . . Conflict in meaning arises in verbal ideas which have opposite meanings, whatever that is; for instance, Meek suggests Strong, and I prefer Strong to Meek.

Once the conflict is given in affective terms. A 84. There seemed to be a quick change from slight unpleasantness (going with the meaninglessness of the statement) to slight pleasantness in accepting it without risking anything.—Several times reference is made to a quick alternation of exemplifying ideas, given in verbal terms. 'These ideas were very vague and flash-like and quick, with almost no content.'

Sometimes the absence of conflict appears to condition belief. A 9. No images to the contrary arose, so the sentence was accepted silently, with a slightly pleasant feeling. A 21. Acceptance seemed to consist in the absence of any conflict between the statement and associative ideas. I cannot describe what the conflict would be like.

The 'fusion of new ideas with memory ideas' appears in many reports from this observer. A 90. There was a slight tendency to accept the statement on account of the ease with which memory ideas occur and fuse with the statement as read. I cannot say what is the form of the memory ideas; just a background of attitude. A 87. I am somewhat doubtful of the last phrase, because I haven't images

enough to illustrate my understanding of it. In other words, the last phrase does not call up images of any kind, with which it could fuse. [On question, the images expected were said to be verbal.] A 22. Very vague memory image of newspaper statement; I don't know what kind it was. I think the memory image fuses with the statement, and that is the acceptance. A 10. Acceptation came in fairly definitely and with moderately pleasant feeling, since the conflict of ideas gave way to the fusion of them.—As to the nature of the fusion, we get a hint, not in the case of the 'new ideas and memory ideas,' but in that of the memory ideas themselves. A 9. The word Beauty was accompanied by a vague background of a host of ideas (verbal-motor in terms) fused together like the tones of the same chord played by different hands in different octaves on the piano. [This analogy would come readily to a highly musical observer.]

(5) A 90. Slight belief. . . This was slightly pleasantly tinged. A 22. Slight pleasantness, may be due to the fusion or assimilation. A 9. Accepted with a slight pleasant feeling. . . Unpleasant feeling accompanied the clash of different [verbal] images aroused by the different parts of the sentence. A 77. Not true absolutely, but may be true on the average. . . The whole state was slightly unpleasant.

Wherever disbelief was pleasant, the pleasantness was of a humorous nature, and found expression in a smile. A 60. At once the reaction set in, expressed by the phrase: That is nonsense, with smile of humor, and pleasantness.

(6) A 3. Agreement was established with a strong pleasant relief. A 13. Belief concludes with a slight pleasantness and a feeling of relief as if from muscular strain. I don't know what muscular strain there was.

Observer F

With this observer we made 187 successful tests. The analysis of belief-disbelief was simple and straightforward: the consciousness consisted (1) of verbal ideas, or (2) of kinæsthetic expression, or of both these factors together. Belief was characterised (3) by a peculiar organic sensation. Only occasionally was reference made (4) to affective processes.

(1) A 133. Acceptance came as: Yes. Also I found in myself a tendency to nod my head for acceptance, and to say again 'yes, that's right.' Acceptance is certainly, in this method of experiment, bound up with verbal ideas. E 7. I thought: Yes, that sounds O K. . . The belief was essentially the Yes. A 6. My acceptance was a verbal one, principally; I thought: That's all right. A 120. Disbelief. . . Tendency to say: It does [fluctuate]; it may be strong or weak. B 3. I thought: Yes—always. Belief was nothing more than the meaning [of the sentence] and the words thought. . . . Belief came again; it was the meaning and a nod of the head. . . Belief came a third time, when meaning of whole was grasped, and was verbal: Yes, that's true.

(2) A 133, B 3, as above. Reports of nodding and shaking the head were very common.

(3) The organic complex was at first indescribable. A 6. Something unanalysable and faint; probably organic sensation; at least I can't think of it as anything else. [Later on it was described.] A 132. There has been in my case also a very faint, very obscure and uncertain organic sensation, coming from just below the ribs a little to the left of the centre. I have mentioned this before but have not described

it, because I was not certain of its nature. [The complex felt like a long narrow slip of pressure. It was not an invariable constituent of the belief-consciousness, but it was reported as constitutive where it appeared, and it appeared frequently with different methods. There is only one suggestion of anything similar in the case of disbelief. A 123. Failure to accept appears to me to be in this case mainly a 'feeling of unwillingness' or 'feeling of inability' to say the thing is true. But I am sure that the inhibition of speech is not all: something organic?]

(4) A 6. Belief. . . Feeling was pleasant, and like the feeling of familiarity, if not identical with it. A 120. Feeling of dissatisfaction, both with the statement and with the author of it.—These affective reactions were very rare.

Observers Cl and P

With the observer *Cl* we made 48, and with *P* 24 tests. The numbers are too small for a final analysis; but we may note a few points of interest in the introspective reports.

The observers are of radically different types. *Cl* is pronouncedly visual, even more so than *C* (the observers, though of the same name, are not related). The understanding of the sentences consisted in the arousal of complex visual imagery, and *Cl* repeatedly said (1) that he could not distinguish understanding from believing; belief was given, at once, with the clear visual images. Disbelief came, not at once, but as a result (2) of the incongruity of the images, which was felt rather than perceived. Both belief and disbelief were intrinsically pleasant; if disbelief was unpleasant, there was a special reason for the change of affective process.

P was of the same type as *G*, and spoke always of belief and disbelief as a fitting-in with or contradiction of pre-existing ideas; the experiments ceased before she was able (3) to analyse this attitude. For *P*, too, belief and disbelief were both intrinsically pleasant.

(1) B 4. Understanding and belief were very closely connected. As soon as I had passed the words 'typhoid fever' I understood and believed. A 135. I am not sure just where the dividing interval between understanding and belief lay, or if there is any such interval. . . I think that the instant I clearly understood the sentence, I also believed it. A 133. Understanding and belief were simultaneous.

(2) The following instances serve to illustrate the observer's wealth of visual imagery, as well as the fact that disbelief depends on their incongruity. B 2. I had a series of visual images, corresponding to cat, house, garden, a second cat, etc., and put them together piece by piece as in a picture until I had, as it were, a series of pictures,—first the cat alone on the background, then the bones alone, then the cat carrying the bones, etc. The whole scene, except the second cat, was familiar. The word 'benevolent' called up a picture of a clergyman acquaintance, and the introduction of this incongruous person aroused my sense of humor and I had a tendency to smile. . . The idea of benevolence in that connection was so incongruous that I refused to accept it. A 125. I recalled from memory a formicarium, but this immediately disappeared, and I imagined the ants as on the table

before me: several of them, scattered over a space perhaps six inches square, were blue or yellow, and were warning off another ant, black, who ran about wildly, and tried to get inside the space. Then the ridiculousness and impossibility of such a scene struck me, and I decided that I did not believe it.

(3) *P* speaks, in general terms, of 'satisfaction at the fitting in of the words to the unformulated content of my mind,' of 'a feeling of disagreement and a tendency to argue in opposition,' of 'something there out of harmony with my own views,' etc. Here we have clean-cut instances of *Kundgabe* as opposed to psychological *Beschreibung*. Neither *Cl* nor *P* had had the general introspective practice of the previous observers, and the present experiments were, as we have said, too few to give positive results. Nevertheless, *P*, who is of the imageless type, is content with a form of words that conveys meaning but fails to describe, while *Cl* is saved from this substitution of logic for psychology by his strongly visual type. It is doubtful, however, if *Cl* is reporting a belief-consciousness that is on the same level with that of the previous observers; the identification of clear understanding with belief reminds us rather of Bain's primitive credulity.

It may be added, in illustration of type, that the observer *Cl* has schematic visual images which carry the meanings of belief and doubt. These images came out very clearly in the later experiments by the method of paired comparisons. C 14. In reading these two, I visualised a small stone sphere, like a marble, next to a larger, more irregular, but generally spherical body like a sponge, the latter being above the former. . . In all these cases the marble represents the more concrete and the more easily understood sentence, the sponge the other.—In reply to questions about these images, *Cl* reported that belief was always represented, for him, by a circle or a ball, of small size, two or three feet away from the eyes, which is very sharp in outline and seems very heavy. Doubt or hesitant belief may be represented by a larger, softer, vague, indefinite and hazy ball. The schematic image for doubt is, however, less constant than that for belief. It may be replaced by other, more pictorial images. B 4. In cases of hesitation I often get a visual image of some familiar country road, one cross-road appearing more often than the others. This picture disappears when the sentence has aroused visual images of its meaning. B 16. I had the impression of being surrounded by a gray mist, which I could enter, but in which I was absolutely lost. C 13. I took the attitude that here was something definite which I had better accept, while my own definition was rather vague and I had not cleared things up. I visualised this as a person standing on a gangway above the water [the clear definition], while near by on the water floated a mass of wreckage or pieces of wood [*Cl*'s own previous ideas].

Method of Single Exposures: Mathematical Expressions, Visual

In this series of experiments we sought to analyse simple forms of the consciousness of certainty or uncertainty. Problems in arithmetic and algebra, of an easy kind, were typewritten on slips of paper. Sometimes no solution was given. The observer was then instructed to read the problem, to solve it mentally, and to introspect the consciousness of certainty or uncertainty which accompanied his result. Sometimes the answer was printed on the same slip; it was covered, at the

beginning of the experiment, by a blank sheet. The observer was then instructed, either to read the problem, to look at the answer, and to verify its correctness by mental computation; or to read the problem, to solve it mentally, and after solution to compare his own answer with that given on the slip; in both cases he was to report upon the resulting consciousness of certainty or uncertainty. A full series of experiments was performed with the observer *C;* brief series were taken with *V*, *G* and *F*.

Observer C

With this observer we made 150 tests. (1) The problems were worked out in visual terms; as a rule, the visual images were clear and definite. (2) The reaction of certainty-uncertainty was more intensively affective than that of belief-disbelief in the preceding experiments; certainty was invariably pleasant, uncertainty unpleasant. (3) Kinæsthetic sensations were more strongly in evidence than in the former experiments, though they are still not a marked or uniform feature of consciousness. (4) The most important and characteristic feature of the certainty-uncertainty consciousness was a visual perception of agreement or disagreement. (5) This perception was clinched and expressed in verbal form.

(1) A 123. I added the numbers as they came with clear visual images of the series. . . The images were so clear that I could not have been much more sure if I had seen the scale before me and counted them out upon it. A 121. I used the visual method. . . The visual images were not clear, and the number that I was to add would sometimes disappear or get mixed with others. A 119. I read the problem and worked it mentally three times, using visual images. A 113. In the first part I had images of the numbers written under one another and proceeded as in ordinary subtraction. In the last part I had an image of the series as numbers on a line marking off distance, with specially large marks at each hundred and smaller ones at the tens. . . I did all the work by means of visual images.

(2) A 123. Affective mood pleasant. A 113. Slightly pleasant feeling; attitude of satisfaction. A 67. The whole process was agreeable. A 121. Uncomfortable feeling; dissatisfaction. . . Pleasurable feeling connected with the agreement. A 112. Very unpleasant. A 71. There was something unsatisfactory and displeasing about the result.

(3) A 121. Strain in eyes and forehead. . . Relaxation of strain [with later agreement]. A 71. Muscular strain about face. A 111. Sensations of strain in the eyes. A 119. Feeling of strain in eyes and forehead. Slight tendency to move the eyes as I followed the imaginary line from 100 to 28. Relaxation accompanied certainty. A 114. Organic sensations from breathing; strain in the forehead and eyes. (Uncertainty.) A 110. Feeling of certainty. . . I breathed more easily; the strain in the eyes is gone.

(4) A 123. I had a high degree of certainty that my answer was right the first time, due I think to the clearness of the visual images and the ease with which they fitted into each other. A 121. I had a

vague image of my numbers on the visual line overlapping or failing partly to meet. I was in doubt about the correctness of my answer. A 136. I was fairly certain of the answer the first time because each separate addition had been clear cut and had itself carried certainty. It is hard to say just what I mean by this. I think the visual image had most to do with it. When I am certain I am right, I can see very definitely to what point on my visual scale the series reaches; when I am not certain, it is less clear, and seems to overlap several points. A 137. Each step was clear and definite in consciousness and was accompanied by a feeling of certainty. This may be described as visual agreement. Each step of the process seemed to fit into the scale and to leave no doubt.

(5) A 113. Verbal images: Second was right. A 112. Verbal images: First probably right. A 110. Verbal image: Mistake? A 114. Verbal images: This is right. A 115. Verbal images: No use to do it again; this is right.—The phrases: First right, Second right, Where's the mistake? etc., were very common.

Loss of interest. It is worth noting that, as soon as the consciousness of certainty had formed, the observer fell into a specific attitude, which she designated 'loss of interest.' A 136. I lost interest in the problem and had no desire to do it again. A 115. Loss of interest in the problem and difficulty in keeping the attention on it any longer. A 118. Loss of interest in the problem. A 117. The problem lost interest. My attitude might be called a feeling that it was of no use to try it again as the answer would certainly be the same.—We have had no opportunity of subjecting this attitude to analysis. Its main feature appears to be a motor relaxation and restlessness, corresponding to lapse of voluntary attention.

Observer V

With this observer we made 50 tests. We found, as before, kinæsthetic and other organic sensations of an empathic kind, and we found (1) that complexes of organic sensations were the essential factor of the certainty-uncertainty consciousness. (2) Certainty and uncertainty are characterised by a fairly intensive affective process, pleasant for certainty and unpleasant for uncertainty. It is, again, interesting to note that verbal images (aside from the names of the symbols) were not once reported. (3) The work is usually done in visual terms.

(1) A 116. A host of organic sensations; pressure on the chest especially. . . The feeling of certainty was distinct: I felt strong and sat up straight. A 120. Many organic sensations in chest, arms and back. Sat up, breathed deep. Had a sense of power. (Certainty.) A 136. Felt certain. . . Got sense of power and superiority. A 144. Feeling of certainty. Organic sensations and usual feeling of power. A 140. Feeling of uncertainty: heavy pressure in chest and arms, felt tired, breathing difficult, frowned. A 142. Feeling that I could not trust myself: sensations of pressure in chest and back, felt tired. A 118. Feeling of helplessness; no certainty at all; creepy feeling in back, and pressure in chest and stomach; felt tired. A 143. A feeling of uncertainty. Mostly organic sensations of pressure in different parts of the body; felt chilly. A 117. At first uncertainty: shivery, prickly sensations in arms. Then certainty: sat up straight. Feeling of safety, which I can't analyse, but I think breathing had most to do with it.

(2) A 119. Pleasant. Sat up, breathed deep, felt satisfied. A 136. Felt certain. . . Restful and pleasant. A 141. Very pleasant and restful. A 140. (Second stage.) Decided feeling of certainty and elation. . . Had feeling of power and satisfaction. A 139. No certainty. . . Very unpleasant. A 142. (See above.) Rather unpleasant.

(3) A 139. Visualised but kept forgetting. A 142. Visualised, but the figures moved; unsteady. A 120. Visualised and did it that way; very easy. A 140. Visualised and made it more easy by moving my pencil in the air as I worked.

Observers F and G

With these observers we made only 20 tests. The following introspections supplement and confirm those already cited under Belief.

F. A 66. Certainty this time seems to be a sensation in back of neck which comes when I nod my head; also an organic sensation located near the place where the organic sensation of belief is, and much like it. A 115. Nodded my head. . . Organic sensation in lower chest, which seemed to be a feeling of 'I thought so' or 'Just as I thought.'—Verbal ideas, of the kind already quoted, were very common. The experience was more definitely affective than in the previous experiments; certainty was pleasant, uncertainty unpleasant.

G. A 141. Distinct feeling of relief with long expiration (must have been holding my breath while computing); said aloud: Yes. Bodily position was changed in relief; straightened out. A 117. Feeling of certainty very strong, expressed itself immediately in the spoken sentence: This must be right. Pronounced pleasantness, and muscular tension in face, as if inhibiting a faint smile. A 142. I was sure (I don't know how to analyse it) that my calculation was right. . . The whole task was verbal, auditory-motor.—Internal speech (or spoken words) and the subsequent emotion of relief are again characteristic of this observer.

Method of Single Exposures: Auditory

At the conclusion of the visual series, we made experiments in which sentences or mathematical expressions were read aloud to the observers by the experimenter. The observers were *C*, *V*, *F* and *G*; about 60 tests were made with each one. The introspections of *C*, *F* and *G* show no new features, and we therefore do not quote from them. We have, however, certain reports from *V* which are worth quotation, as they seem to throw light upon the analytical psychology of suggestion (religious conversion, etc.).

B 2. A flash of belief came at this moment. Seems to take hold of me and envelop me. I felt light and airy, cool, rested and relaxed. The sense of belief is not an intellectual thing. The reasoning comes first, and after the actual reasoning process is concluded the rush of belief comes with almost physical force. I feel that I believe, and the thought or idea of what I believe is not present at all. The belief in its momentary flash is not referable to any object. B 1. Then came a feeling of belief. It seemed to come upon me from

outside and envelop me like a gust of wind or a flash of light. I sat straight, felt refreshed and relieved and satisfied. B 4. I came through this [reasoning process] and stopped and believed. As soon as I believed, I forgot everything. Sat up straight, breathed deeply, felt strong. Pleasant. B 7. Then I had a decided disbelief, very clear and definite. It seemed to come from the outside. I had kinæsthetic sensations from straightening up, and organic sensations from long breathing, and I had a feeling of superiority. B 11. Disbelief came on me as a strong wind from the outside.

Several reports of Doubt were obtained in this series. B 8. Then understood and felt doubt, with sensations in chest, frowning, heavy feeling in arms. B 9. Doubt, as organic sensations in chest and arms, turning head and squinting of eyes; breathed with difficulty. Unpleasant.

Method of Paired Comparisons: Sentences, Visual

Our observers were now trained to the fulfillment of the *Aufgabe* or problem of the experiments, and instances of belief were becoming far more common than they were at the beginning. We thought, however, that the method of single exposures could yield no further results of importance, and we feared that the introspections might take on a stereotyped form. Hence we had recourse to a method of paired comparisons. Sentences, so chosen as to evoke belief and disbelief, were typewritten upon slips of paper. The observer was instructed to read them, to note the appearance of belief or disbelief or both, and then to report introspectively upon the belief and disbelief consciousnesses. The regular observers were *V*, *C* and *F*; a few observations were also made by *G*.

Observer V

With this observer we made 246 successful tests. We need not again illustrate *V*'s tendency to empathic kinæsthesis. We note that belief and disbelief are characterised (1) by a fairly intensive affective process; if the belief and disbelief are strong, the affective accompaniment is almost always pleasant for both; if they are weak or but moderately strong, both consciousnesses show a ratio of pleasantness to unpleasantness of approximately 8 : 5. There is no trace of any regular distribution of the affective processes, pleasantness to belief and unpleasantness to disbelief. Doubt, however, is always unpleasant. (2) The most important factor in the belief-disbelief consciousness is an organic (mainly kinæsthetic) complex, the nature of which is shown in the following quotations.

(3) *V* again showed the threefold type of reaction: belief-disbelief, deliberation and verification, belief-disbelief once more. When decision had been taken, (4) there was muscular relaxation and the emotion of relief.

(1) C 13a. Clear, strong and pleasant belief. C 15b. Belief grew till it was maximally vivid, strong and pleasant. C 17b. Disbelief strong and clear. Interesting; . . . felt amused and smiled. C 14b. Belief very pleasant. C 20a. Belief was strong and pleasant. C 20b. Disbelief was strong. . . Feeling pleasant. C 59b. Got an amused but decided disbelief. . . Pleasant; smiled. F 4a. Got at once clear, strong disbelief. . . Felt disagreeable, cross and impatient. F 10b. (Disbelief.) This was pleasant, and disbelief differed from the belief of the other sentence only in its name.

(2) The 'feeling of power' was frequently reported in connection with belief and disbelief. C 41a. Strong tendency to disbelief. . . Felt strong. C 48b. Strong and decided disbelief. Felt superior and rather cross. Felt like pounding the table. F 2b. Believed it. Organic sensations of power, with deep breathing. F 11b. (Disbelief.) I had the organic sensations of power that meant I was sure my decision was right. C 22a. Strong feeling of power. Intense belief. C 9b. Disbelief. . . A sort of amused, lenient but decided sense of power. C 1b. Decided disbelief. Felt supercilious and haughty. F 25b. The feeling of disbelief was quite sure, and I had the feeling of power. [On question from the experimenter, the observer declared that she could find no psychological difference between belief and disbelief.]

In most cases, the 'feeling of power' was connected with the perception of straightening up in the chair. F 22a. Feeling of power and strength; sat up straight; deep breathing. F. 14a. Frowned; held my breath. . . Felt sense of power; sat up straight. (Disbelief.) F 14b. Clear, intense belief. Sat up, smiled, felt strong. F 10a. This certainty of being right is carried by organic sensations of power. I sat up, smiled, breathed deep, puffed my chest out. C 49a. Disbelief. . . . Took breath, sat up, and felt sense of power. C 29a. Felt superior, sat up straight, smiled. Disbelief clear. C 13a. Clear, strong . . belief. . . Sat up, breathed deep, and had sense of power; satisfaction. C 20b. Disbelief. . . Felt haughty, and had sense of strength. Sat up straight.

Sometimes, however, organic sensations are reported without reference to this 'feeling.' F 25a. (Belief.) Organic sensations and motor image of nodding my head. Strong breathing and sensations from diaphragm. Kinæsthetic image of sitting up. F 19a. Intense belief. . . Organic sensations and kinæsthetic images of sitting up straight. F 13a. Belief . . is clear and intense (deep breathing, sitting up straight, etc.). C 28a. Decided sense of belief . . . Felt satisfied, sighed, leaned back in chair. D 10a. Felt sure and satisfied. Sensations from sitting up. F 7b. Belief at once . . . I nodded my head, sat up straight, breathed easily, and felt comfortable.

Change of breathing is especially frequent with strong belief or disbelief. F 14b. Clear intense belief. . Breathed easily. F 5b. Belief is clear . . Long easy breathing. F 2b. Believed it . . Deep breathing.

In the following instance of strong belief the 'feeling of power' is identified with kinæsthetic attitude. F 27b. Kinæsthetic image of nodding the head very hard. I had feeling of activity. Feeling of activity or feeling of power means sitting up, deep breathing, and all the other muscular and organic sensations that I have mentioned.

Nodding and shaking the head are fairly often reported. F 27a. I got belief without getting meaning clear. It was simply a tendency to nod the head. F 5a. Feeling of acquiescence; nodded my head a little in faint acceptation. C 58a. Shook my head emphatically,

meaning: No. F 3b. Disbelief consisted in rigid muscular state, shaking the head, and sensation of drawing away from something. F 14a. Felt confused: frowned, held breath, shook head.

The organic sensation of tingling is peculiar to this observer. F 14b. Intense belief. Had tingling sensations all over me. F 20a. Especially tingling sensations in the spine, which I am likely to have with intense belief.

Strong disbelief is also evidenced by bodily stiffening and shrinking: *cf.* F 3b above. F 4a. Rigid muscles, with nervous movements of hands and feet; rapid breathing; drew back. F 6b. Shaking head in dissent; shrugging back with shoulders, twisting mouth, breathing out rapidly. F 1a. Sensations from breathing fast, with muscular strain especially in face; motor image of shaking head; stiffened and drew back. F 14a. Shook head. General muscular contraction; kinæsthetic image of stamping foot.

The 'feeling of power,' in its intense forms, is characterised as a feeling of aggressiveness. C 29b. Felt aggressive and rather angry . . . Felt actively opposed and displeased. Unpleasant, breathed fast, felt hot, frowned. C 8a. Felt a sense of power and aggression. Felt angry and grew hot. Disbelief very strong and decided.

Verbal ideas were infrequent.

(3) F 6a. Read it twice. . . Smiled, and got feeling of disbelief. [Stage of wonder and thought.] Felt that I was right, and the disbelief-sensations returned. F 12b. Intense belief at once. [Then stage of forced or voluntary deliberation.] Feel that I am right. F 14b. Intense belief. [Stage of consideration.] Belief was very intense and clear. F 19a. I got belief before I stopped to get meaning. [Consideration of meaning.] Satisfied I was right.

(4) C 14b. Belief . . . Calm and comfortable. I leaned back and felt rested. C 41a. (Disbelief.) Relief; felt rested and strong. C 45a. Belief . . . Felt amused and contented with myself. Felt rested. F 1b. (Belief.) Organic state peaceful. General feeling of muscular relaxation. F 5b. (Belief.) Restful relaxation of muscles. F 19a. Satisfied I was right (this consisted of muscular relaxation, and relief).

V used various adjectives to characterise her beliefs and disbeliefs. All of them may, according to her own subsequent report, be reduced to the two pairs strong-weak and clear-vague. 'Solid' and 'decided' were employed as synonymous with strong; 'distinct' and 'definite' as synonymous with clear. The intensity of belief varied with the intensity and massiveness (spatial distribution) of the kinæsthetic and other organic sensations with which the introspective records have made us familiar. The clearness or definiteness of belief depended, in logical terms, upon the relation of the statement to pre-existing knowledge. A belief was clear if it stood in associative connection with particular memories, which justified it. Usually, this relation, so far as it is conscious, is for the observer a kinæsthetic attitude; in the present experiments, a visual image (less frequently, a form of words) tended to replace the attitude. Sometimes, however, the clearness of the belief was kinæsthetic; so that we have the very curious fact of two kinæsthetic attitudes—those of

belief itself, and of the clearness or definiteness of belief—somehow combined, or superimposed the one upon the other. We regret that we have been unable, from lack of time, to trace this complexity further.

F 14b. (Belief was intense and also clear.) I knew why I believed, and this was what made it clear. Got visual image of philosophy class; this seemed to mean 'If religion is properly interpreted, it need not conflict with science at all.' F 7a. The clear element is what I call the logical element; I know why I disbelieve. The intensity of disbelief depends on the organic sensations, and on whether I feel I am justified or not [this 'feeling of justification' has been analysed in previous reports].—On question from the experimenter: The clear element came from memory of lessons in biology. I think I visualised the text-book. F 10ab. On reading first statement I had a sense of familiarity. Got successive visual images of the observatory at Vassar where I saw sun-spots, and of several people I knew. . . Belief was clear because I knew why I believed it; had learned the fact in elementary astronomy. . . The clearness of belief comes more from a logical, the intensity from a psychological process. . . On reading second statement . . I got immediately clear, strong disbelief. I had the sense of familiarity, and had visual image of a telescope, and of the moon as seen through it. . I knew why I did not believe it; I had been shown good proof of the impossibility of life on the moon. I felt (organically as before) that I was right.—On question from the experimenter: The clearness came with, or was attached to, the visual images. My sense of familiarity is usually kinæsthetic and organic, apart from the affection; I think these sensations were there too, but I didn't pay attention to them. F 26a. Then I got verbal association of some experiment done in a woman's college. . . Then I was inclined to disbelieve. Disbelief was not intense, but quite clear . . . I understood why I disbelieved. . . Weak and intense belief differ only as regards intensity of kinæsthetic and organic sensations; they differ in degree. Intense belief can be more easily localised; strength of belief is muscular strength.

In the cases quoted, we find visual or verbal images that carry the clearness. The reason that the observer speaks of clearness of a 'logical' matter is that oftentimes a belief 'feels' clear, touches off the verbal report 'clear,' without there being anything in consciousness—or at least, anything discoverable by the present method—to serve as specific vehicle of the clearness. A clear belief is a belief which could be justified later, by explicit argument, if the observer were challenged to justify it. We are reminded of Störring's 'state of assurance,' which may apparently exist only as a physiological disposition.[1]

Observer C

With this observer we made 225 successful tests. The most important feature of the belief-disbelief consciousness was, again, (1) a perception of visual agreement or disagreement, which (2) was clinched and expressed in verbal form. (3) Kinæsthetic sensations and organic sensations were more in evidence than in the first series of experiments, though they were still not a marked or uniform feature of consciousness.

1 *Cf.* Titchener: Thought-processes, 1909, 289 f.

(4) Affective processes were neither frequent nor intensive; belief was pleasant, disbelief pleasant or unpleasant.

(1) F 14b. (Belief with reservations.) The belief and disbelief were carried partly by Yes and No. But the main thing was something visual; hard to describe. I had two long lines, moving parallel to each other: each one had branches, hitting those of the other. That was conflict; the main things did not conflict. C 42a. Belief. This is hard to describe. There were visual images, more or less fragmentary or schematic, representing peculiarities of poets, and these were somehow seen to agree with the statement. F 27ab. Belief in both cases. . . Visual image of adult, and then of child; reference to my own experience. That was a line representing the time from the present to the past; there was nothing more that I can tell. . . Memory of child was very plain, but scattered and disarranged; a visual pattern made up of bits, which were very clear, and which I could see very plainly; clear cut, and separate from one another. Memory of adult was like a spider's web, clear, all united. . . All this fitted in, in some way, with the reference to past experience; I believed; the two things fused together; but I can't say whether at this stage there was any representation of past experience.

Sometimes a visual schema for 'past experience' is reported. D 4a. I had visual images representing will, past experience, etc. . . . When I say I believed, I cannot say that there was anything in consciousness except the mere visual image representing the meaning of the sentence, which was seen to agree with the visual image of previous opinion. This latter was present at first as a dark, vague object in the visual field; after I began reporting, it translated itself into words. C 48a. There was something in consciousness which represented the interpretation of animal action in human terms. It is hard to say what it was. I am sure that it was in part at least visual, but I cannot describe the image. It seemed to agree with the statement; it was a visual perception of this agreement. C 7a. It is very hard to say in what this belief consists. I usually have a schematic visual representation, sometimes very vague, of previous opinions on the subject, and seem to see an agreement between that and the present sentence. The assent is partly verbal sometimes, often expressed by the one word Yes; but I am sure that this is not always present. D 9b. I believed the statement; but it is hard to say what this consisted of. I think it was mostly visual. My schema of feelings of familiarity was seen to coincide with that of the feelings named. C 2b. On reading I had a schematic visual image which represented evolution and progress to me. It was very vague and I can't describe it. I assented; the assent or belief seemed to come as agreement of this schema with that of previously accepted opinions. D 7a. Visual image of two parallel lines, at first in some large, vaguely seen plane in space, then on a page of the geometry I used to study. Visual image of the outside of the book, and verbal image: Wentworth. Verbal image: Euclid. In the image of the lines I seemed to see that they were just as far apart from one another in one place as in another. The lines as I saw them did not meet. My belief consisted of some perceived agreement between the statement on the paper and that of my geometry. I cannot remember anything in consciousness, except the visual imagery, that carried the belief. C 43a. Visual image of a mob in the street. At first identified as a scene in the Tale of Two Cities; then it changed to a scene in Felix Holt. When I say it was a scene in these books, I don't mean that I said the names of the books till I came to report. The scenes in either book seem like

independent things to my imagination, and I see them in their place and know what they are without any verbal image. Then visual image of Calkins' Psychology and memory, I think wholly visual, of a passage in it. Belief. This seems again to have been a perceived agreement between the sentence and my images.

The two last introspections have been given with some fullness, in order to remind the reader of the typically visual character of *C*'s thinking. We proceed with descriptions of belief. F 4b. Visual image of a man hypnotising a subject by waving his hands before his face. As this seemed to fit into the schema for 'absence of any stimulation,' I believed the statement. I cannot describe this belief further than as a coinciding of the visual schemas. F 1ab. It is hard to define the difference between the certainty itself and the contents because they were so closely connected. The content came as a visual schema, and the certainty seemed to consist in the fact that it fitted a previous schema in my mind. I did not see the two separate at first and then coinciding; but there were no ragged edges; they coincided. C 14a. The belief was only slightly if at all verbal. It consisted of strong organic sensations and of what I can only describe as a perception that the schematic visual image produced by the reading fitted those already in the mind. I know that this description is not accurate. I do not mean that I first had the schema of my own opinions, and that the new schema then fitted into it, or that they were both there and moved into each other like the double images in stereoscopic vision. There was the one representation; but there was nothing outstanding that did not come under the statement. F 12ab. The belief here was expressed by a partial agreement with the schema of my ideas, and by a vague image of a book from which the statements were taken. This was especially clear in the second sentence, where the agreement was followed by the image of a book which I read last week and in which the ether is discussed. F 3ab. On reading first statement there were in consciousness only the verbal images of the words and a vague visual schema. There were the same in the second and, besides, a reference to Marbe's work on judgment. I think that this reference was visual, that is a visual image of the book and of the name Marbe as printed. There was also a vague visual schema of Marbe's conclusions, and outside this, below a straight line which separated the two, an image representing the Aufgabe. If the feeling of certainty was something distinct from the facts I have given I do not know how to describe it; I find nothing else. In the first there were no ragged edges in the visual schema; it seemed to fit my previous ideas. In the second, the Aufgabe below the line represented in some way an exception to the statement. D 1a. Belief came immediately, but it is hard to say in what form. It seemed to be what I call perceptual. I saw myself in the dreaming state and saw that that and my present state did not agree, just as I might see that the chair and the table are not the same thing without any explicit process by which I arrived at this conclusion.

C 36b. Visual representation of the two sentences at the opposite ends of a line; this meant: They are contradictory. C 31b. Visual image of some nerves, with the idea of a current passing along them; I think this was mainly visual too, in the form of undulations. Verbal ideas: Soul, and Electricity. Disbelief. This was mostly visual. It was a perception of the incongruity of the two; the visual images did not coincide. D 8b. (Disbelief.) I think it was mostly visual. My image of the elasticity of the brain-cells did not suffice for intelligence; did not cover it. There was a dark hazy halo round the outside which represented the rest of intelligence. C 41a. Verbal idea:

Perhaps not. This was accompanied by a vague visual image of an ill-defined dark mass which seemed to represent other possibilities not here considered. The meaning was that there were other things to be said; but this was not expressed in words. F 2a. Verbal idea: Dangerous. Visual images of something cut, but still mingled up again. In one way I believed, but in another way I did not believe. F 19b. Visual images, not only of the body itself, but of bodily processes. I had the contents of the sentence visually in mind, and I had visual images representing substance and power;—dark spots, very vague. The pictures seemed opposing; I did not believe; unpleasant affective tone. Then I had verbal ideas; just two or three words, I can't remember. Then the opposition of the images disappeared; they fitted together; and I believed the statement. F 8b. Mental contents were visual images. Belief consisted in their nearness together; there was also agreement with past schema. D 2ab. As between these two sentences, the first seemed much more definite and nearer. The image in the second was vague and very far away and inaccessible. The distance between it and myself seemed to offer an insuperable barrier, like the distance to the stars. With the first, though it was definite and near, there was a sort of background of doubt, a cloudy something that seemed to lead out in all directions and indicated that influences in human character are hard to measure. In reporting, this came to me verbally, but it was a visual image of a cloudy substance that seemed to radiate in wide, blunt strands in every direction from the central image.

(2) F 10b. Distinct visual images of the moon, and of living beings walking round on it. Verbal idea: Don't know. Then: If there are such beings, the telescope might reveal them. I think the last was not completely expressed in words, as here; it was partly visual; I seemed to see a telescope directed upon them. In these cases the visual images constitute the mental contents coming from the meaning of the statements, and the verbal ideas and visual agreement or non-agreement with the other schema constitute the feeling of certainty. C 24a. Visual image of a negro. . . Then visual image of a professor of sociology. . . His statement was clearly present in the form of visual images. . . Neither belief nor disbelief on first reading; on second reading, verbal ideas: They are the same, meaning inborn difference and heredity. Noticed word: Social. No decision; feeling of confusion; sensations from breathing. Later disbelief, which came in the form of words; something like: All heredity is not social; though more scrappy.

Brief verbal images: Yes, No, Probably, Perhaps, Indefinite, Clear, Of course, On the whole, etc., were exceedingly frequent.

(3) F 1b. Belief. . . Organic sensation from region of the diaphragm; I think, with the belief, though it may have come later. C 14a. Strong organic sensations from region of diaphragm and higher up in the lungs in connection with breathing. (Belief.) F 19a. Belief was just visual fitting; there was one image, and there was fitting; prevailing pleasure, and organic sensation in diaphragm. These all seemed to be mixed up together.

Reports of this sort were rare. The sensations from nodding were occasionally reported; never those of shaking the head. F 21a. Slight tendency to nod the head, and repeated nodding as I went on reading. F 6a. Very slight kinæsthetic image of nodding my head. This is the only fact that I can give as belonging to the assent.

(4) C 8a. Very strong disbelief. . . Slight feeling of amusement and tendency to smile, with accompanying sensations from face. C 9b. Strong feeling of disbelief. . . Feeling of amusement and tendency to

smile. F 19b. (Disbelief.) Unpleasant affective tone. F 15b. Black background with a mere chaos of figures and unpleasant affective tone. I don't know if the word No was present. . . I think the disbelief was carried partly at least, in some of these cases, by verbal images and affective process. C 15a. (Belief.) Attitude of satisfaction. This was a pleasant feeling, with a tendency to proceed at once to introspection and not delay to consider the question. C 16b. Assent. . . Present as a feeling of satisfaction and pleasure, accompanied by a visual schema. D 1b. The question was settled immediately. Belief; feeling of satisfaction; inhibition of further effort.

C characterised her beliefs as strong, weak, faint, definite, indefinite, sharp, clear, focalised. She made no such distinction between intensity and clearness as was drawn by *V;* possibly the difference in mental type may account for this difference.—The two first of the following reports were obtained by question from the experimenter; the third was volunteered by the observer.

C 4ab. The degree of belief was about the same in these two cases. There was some doubt in both; that is, there was a tendency to think of exceptions, which were partly visual, partly verbal in consciousness.—I can scarcely say that the nature of the beliefs was different psychologically. I thought verbally that *b* could be got from actual observation, while *a* must be more theoretical and a matter of individual opinion. But this, as a difference between the two beliefs, is a matter of logic rather than of psychology. It was present in consciousness, so far as it was present, in words. The conditions of belief in both cases included vague visual images. C 5ab. Belief slightly greater in *a* than in *b*. Here also the grounds of belief differed logically, and were expressed verbally (so far as present in consciousness). Verbal idea, like: Insufficient negative proof, in consciousness with *b*. C 15b. There was a difference between this belief and that of *a*. The latter was greater, but there seems to have been some qualitative difference which it is hard to describe, in psychological terms. That in *a* was more sharply defined, and decisive; that in *b* was broader and more vague. I believe that these terms apply to the background of organic sensations, but I am not sure.

Observer F

With this observer we made 184 tests. The analysis of belief-disbelief gave (1) verbal ideas, or sensations of kinæsthetic expression, or both of these factors together. Belief was characterised (2) by a peculiar organic sensation. (3) Affective processes are more frequent and stronger than in the first series of experiments. They are very variable, within the course of a single observation; on the whole, however, belief tends to be pleasant and disbelief unpleasant. They are often connected with a change of breathing.

(1) We begin with the verbal images. C 44b. Belief came at the first reading as No. That is, I believed the statement, but said No as negating a third mental element. F 2a. At the end of the first sentence I said No; I could feel the tone, so to speak, not like a mere kinæsthetic image, but like the actual sensation. Just exactly as if I

had actually said No. Sometimes No expresses belief and Yes disbelief. F 14a. At the end I said: No, these count (verbal-auditory image). The words: These count, stood for all that I had learned in ethics and philosophy. F 14b. I said Yes, with a sort of muscular set all over my trunk, especially along my sides. F 24b. As soon as I had finished reading I said: I don't know—I suppose so. Between the two there was a general emotional mood with a bodily set, meaning something like But. With the second term there was kinæsthetic image of a shrug of the shoulders; indifferent. The whole mood was a sort of acceptance. C 29b. Verbal No; complex of muscular and organic sensations that I should now interpret as: That's all nonsense. F 5b. Read, and said: Rheumatic babies (auditory-motor). There was nothing behind; that was the belief. I had had strains, particularly in shoulders and upper part of body in *a*, but I was relaxed when I came to *b*.—There were many cases in which a word, Yes or No, was the whole of the belief or disbelief consciousness.

F 3a. I said Yes to myself and nodded my head. C 31a. Belief came at once in a Yes, auditory-motor, with a muscular sensation in middle of back of neck. F 23a. Belief was kinæsthetic image or sensation; I don't know which. It was at centre of back of neck, very much like the sensation of nodding. C 1a. Tendency to nod my head. Had sensations (muscular) at back of neck. F 4b. Said No to myself, and actually shook my head.—Reports of this kind were very common.

(2) C 1b. Organic sensation when meaning was clear and belief came. . . Localised in the abdomen, a long narrow transverse and rather weak sensation. C 2b. Organic sensations, not localisable exactly. F 3a. Got usual organic sensations from abdomen.—These sensations never appeared with disbelief.

(3) F 7a. (Disbelief.) Rather unpleasant. . . While it was unpleasant, I had disturbance of breathing. F 10a. The verbal images, the sensations from change of breathing, and the unpleasantness seemed to make up a single complex. (Disbelief.) F 1b. Said: Of course; rather pleasant, with slight relaxation of breathing. F 2b. Said No; unpleasantness and breathing strain. Said Nonsense; had strains in arms and shoulders, and very definite set or bodily posture. Unpleasant. F 5b. Disbelief, quite sure, rather unpleasant. C 23b. Affective processes changed so often that I can hardly describe them, but disbelief was rather unpleasant, while belief was pleasant. F 13b. Said No; rather unpleasant. At the same time, organic sensations from breathing, such as I might have if I heard: You're a liar, only weaker. Weak muscular strain in chest.

Observer G

Only some 20 observations were made by this observer. We append a few characteristic introspections.

G 1ab. Consciousness mostly verbal. In reading first sentence, tendency, verbal and kinæsthetic, when I came to the word *goes*, to say: Does not go. . . After finishing second sentence, two tendencies, kinæsthetically to nod head, and verbal-motor as if to say: That's all right. I can't analyse the verbal tendency more. It was simply an innervation of the tongue, and sometimes larynx, to pronounce the first sound of each word. G 5b. Nodded to it and said Yes to it. G 7a. Verbal ideas: No, Bismarck is greater, Gladstone is greater; don't believe it. Only partly articulated; I wanted to whisper it. G 7b. Tendency to smile and to say: That is absurd. Tendency to smile consisted of strains in the face, especially around the eyes; with a flash there came a host of verbal ideas, in shorthand, about the dis-

turbance in the Orient; too complicated and vague to be analysed. G 12a. All I remember is a vague verbal tendency, meaning: At least business men believe it. This was very much abbreviated. G 5a. Host of verbal associations, abbreviated and condensed; one of these was a change of the sentence into: Drinking makes some of us happy. That too was abbreviated. Then there was a very vague, kinæsthetic and motor attitude, representing a woman of the total-abstainer kind, with disgust for drunkard, turning away her face and head and wrinkling her forehead: these things seemed to occur in my own case (feeling of disgust, tendency to turn head and wrinkle forehead). There were words in this too. [This empathic kinæsthesis is rarely reported by *G.*] G 12b. Very vague sort of visual image of grocery store on College Avenue, with vague square show window; vague image of clerk with long apron. Tendency to smile, with kinæsthetic and motor attitude as if I was buying in that store.

Method of Paired Comparisons: Mathematical Expressions, Visual

We introduced two modifications into the procedure of the introspective method. The one of these was that we asked the observers, at the conclusion of the principal series of experiments, if they could suggest any further work that might throw additional light upon the nature of the belief-disbelief consciousness. The observer *C*, in response to this question, suggested that a short series be taken, by the method of paired comparisons, with mathematical expressions instead of sentences.

Observer C

The observer gave 50 observations. (1) The certainty-uncertainty consciousness was strongly affective; certainty was pleasant, uncertainty unpleasant. (2) Kinæsthetic sensations are present in many cases, though they are not prominent features of the records. (3) The most important thing is a visual perception of agreement or disagreement, which is (4) clinched and expressed by words.

(1) G 25a. Felt quite certain. Satisfaction. G 26a. I was quite certain; pleasantness was contained in it. G 42b. I had vague schematic image of possibility of making a mistake, and it was very unpleasant. G 43b. Frowned; it was very unpleasant . . . I got the feeling of uncertainty; unpleasantness. G 41b. Very easy and pleasant.
(2) G 32a. Certainty . . . Relaxation of muscles; sat back. G 34a. Dissatisfaction and unpleasantness; restlessness, and general muscular strain. G 41a. Tension of muscles. (Uncertainty.) G 41b. Feeling of relaxation. G 43b. Strain in hands and upper part of body . . . I got the result; nodded.
(3) G 40b. Since the number was so large, and contained so many terms, I always forgot the preceding images when I came to the next stage . . . Lack of clearness; this was simply confused images of a lot of numbers. Also very vague schematic images of those places where I might have made a mistake. G 25a. Visual images were very plain; clear cut. I could see it was right. Everything was very clear visually; the numbers were at their right places on the scale. G 26a.

Certainty was caused by clear visual image; there was no overlapping. Saw number-scale for numbers higher than 100. G 42b. Tendency to try it over again, that is, to start in again. When I had another answer, I had both answers in clear visual images; but they looked entirely different. I can only say that the one looked as if it fitted. [The observer remarked, G 30a: I don't know how to describe the tendency to repeat, to start over again. It is anyhow partly visual. Very vague visual image of possibility of getting another answer. It is too vague to describe. There seems to be kinæsthesis behind it. G 43b. Strain in hands and upper part of body, which composed the tendency to do it over again. Sometimes this set was more prominent, sometimes the images were prominent; vague visual schema of chance of mistakes; a big confused mass with everything mixed up.]

(4) G 42b. Here images were so fleeting that I could not use them; I did not feel sure at all. Hence I worked both visually and verbally. G 43b. I said the numbers to myself. G 40b. Performed partly visually and partly verbally. G 32a. Clear images, visual and verbal. G 24a. Idea that I might have forgotten, might have been mistaken (partly verbal; also visual image of something that had a blank space).

Experiments with Tones

At the request of the observer *F*, we made a series of 50 experiments as follows. The experimenter took two tuning-forks, of 256 and 260 vs. respectively, and after a signal struck in succession either the two forks (A-B or B-A) or the same fork twice over (A-A or B-B). Having struck the forks, he pronounced the word Same or Different, irrespectively of the actual relations of the tones. The observer was to react to this judgment expressed by the experimenter, by way of acceptance or rejection, and was to give an introspective account of his consciousness.

The introspections were complicated by the kinæsthetic attitude of expectation. As regards agreement and disagreement, we find (1) that, almost without exception, *F* has verbal ideas: Yes; No; Yes, same; No, same; Yes, different; No, different, etc. (2) Further, in the majority of the reports there is nodding or shaking of the head, actual or imaginal. (3) The affective accompaniment is marked: agreement is always pleasant, disagreement always unpleasant.

As these results simply confirm the previous analyses, we do not print extracts from the introspections.

Final Interrogation of Observers

The second modification of the method that we introduced is that, at the conclusion of the whole investigation, the experimenter reduced the introspections to a single formula, which was laid before the observer for approval or disapproval. We regard this procedure—a sort of procedure by confrontation—as important in work of the kind here reported. The experimenter amasses a great bulk of introspective material, which he has to sort, evaluate and arrange, and from which he

has to draw psychological conclusions. By rights, perhaps, the whole of this material should be printed as an appendix to his paper; but no Journal has space for it. There is always a risk, then, that the experimenter put upon the records an interpretation which is not shared by the observers themselves: witness the classical instance of Bühler and Dürr. If, however, he read to the observer, when the work is completed, his digest of the reports dictated, then the observer has an opportunity to say his say independently; he can declare his agreement or disagreement with the conclusions. His approval must greatly fortify the whole argument of the paper; his disagreement should lead to further study of the consciousness in question.

Our observers did not know beforehand that this method would be followed; but all of them expressed their approbation of it when it was actually employed. We proceed to the details.

Observer V

The experimenter read to the observer the following summary statement. "For the observer *V*, belief-disbelief is characterised by fairly strong affective processes, which tend towards pleasantness. The affective process accompanies a characteristic kinæsthetic-organic complex, which forms the core of the belief-disbelief consciousness; if a single name is to be given to this complex, we may term it a 'feeling of power' or 'of aggressiveness.' Verbal ideas are rare in the consciousness; the contents of the belief are usually visualised. In the case of certainty-uncertainty, we find the same type of consciousness, except that certainty is pleasant and uncertainty unpleasant." The observer unhesitatingly accepted this analysis.

The experimenter then asked whether *V* had ever come across anything in the way of an imageless content, either in belief-disbelief, or in any other consciousness accidentally aroused during the course of the experiment. The answer was negative.

The observer was then asked how she distinguished, psychologically, belief from disbelief. She replied: "I don't know, except that my feeling of power means sometimes arguing for and sometimes arguing against. Perhaps a variation of the method would bring out some difference in the feeling itself, but I don't think so. I was working under the alternative Aufgabe, belief *or* disbelief; the consciousnesses seemed to be alike, but their meaning was different."

Observer C

The experimenter read to the observer the following summary statement. "For the observer *C* the belief-disbelief con-

sciousness is not a markedly affective experience; in general, belief tends towards pleasantness, disbelief towards unpleasantness. Nor are there pronounced kinæsthetic-organic components, although these sensations may appear and may be integral to the consciousness. The core of belief-disbelief is to be sought in the arrangement and behavior of visual images, which represent both the materials of belief and the pre-existing mental furniture. The visual images are often supplemented by verbal ideas, in which also the belief-disbelief consciousness reaches its terminus. In the case of certainty-uncertainty, consciousness is more strongly affective (certainty being pleasant, uncertainty unpleasant), and the kinæsthetic-organic sensations are more in evidence." The observer accepted this analysis.

The experimenter then asked whether *C* had ever noted anything like an imageless content. The answer was negative, though *C* said that there were many attitudes that she had not been able to analyse, under the conditions and with the time at her disposal; some of these, she remarked, had been analysed by other observers in the work which she herself was conducting. [This work is a general study of the Conscious Attitude.]

Since belief and disbelief had been sufficiently distinguishedl in the introspective reports, by the characteristics of the visua. imagery, no question was asked concerning their discrimination

Observer G

The experimenter read to the observer the following summary statement. "For the observer *G*, belief-disbelief is characterised by moderately strong affective processes, which are normally pleasant for belief and unpleasant for disbelief. The core of the consciousness is constituted of verbal ideas, some of which represent habitual verbal reactions, and others of which are more complicated; these latter are given in a peculiar abbreviated form. There is evidence of kinæsthetic sensation, though this is oftentimes not at all prominent in consciousness; there are occasional visual and auditory images; but, essentially, the whole consciousness is verbal."

The observer accepted this analysis, with a reservation which did away with any necessity for a question regarding the occurrence of imageless thought. He said that the analysis was complete, so far as it went; he found no other contents, imaginal or imageless. But he declared his conviction that belief-disbelief was a course, a mode of conscious processes, specifically determined by the Aufgabe; and he added that analysis would not be complete if reference to this pattern or mode of occurrence was omitted.

We are here in presence of a very difficult psychological prob-

lem. We met it also in the early stages of *C*'s introspections, though as time went on *C* laid greater emphasis on the spatial arrangment and mutual relations of her visual images, and less upon the belief-meaning which the separate images seemed earlier to embody. Something of the same sort appears in Ach's sensations of intended movement; sensations of intended finger-movement, it will be remembered, might occur in the eyes. We have already mentioned Störring's state of assurance. Titchener gives an instance of recognition, performed under instruction without a trace of any specific contents (*Thought-processes*, 1909, 179 f., 289 f.). Ach speaks in the same way of volition (*Willenstätigkeit*, 195, 231; *cf.* Messer, in *Arch f. d. ges. Psych.*, viii., 1906, 199 ff.). We need not multiply instances. It seems clear that a certain meaning—intention, recognition, assurance, volition, belief— may be bound up with, incorporated in, a sequence of mental processes which proceed under determination, though there is nothing specific in these processes to serve as the psychological vehicle of that meaning. They go on in a certain way, under the instructions given; and their going on in that way constitutes them will, recognition, belief, etc.

This position, we may add, was several times discussed by the observer *G* and the experimenter, and was accepted by the observer without reservation. It seems especially important to note that *G* finds no trace of imageless contents, since he is precisely of what has been described as the imageless type.

Observer F

The experimenter read to the observer the following summary statement. "For the observer *F*, belief-disbelief is not a markedly affective consciousness, though under certain circumstances the affective processes may be moderately strong; the affective reaction is very variable, but normally belief tends to pleasantness, disbelief to unpleasantness. The core of the consciousness consists in the verbal ideas Yes and No, or their equivalents, and in the kinæsthetic sensations aroused by the gesture of nodding and shaking the head. A special organic complex is a frequent component of the belief-consciousness. Oftentimes there is a general kinæsthetic reaction, in which sensations from breathing are perhaps most prominent." This analysis was unhesitatingly accepted by the observer.

The experimenter asked whether *F* had found any trace of an imageless content, and the answer was negative.

Conclusion

We may sum up the results of the present enquiry as follows:

(1) The belief-disbelief consciousness, in any form more pronounced than a quasi-mechanical acceptance or rejection, is not of common occurrence in everyday life, and at first is not of common occurrence under experimental conditions. If the instruction is given to observe and report upon this consciousness, however, it appears fairly regularly in response to fitting stimulation.

(2) The belief-disbelief consciousness is not necessarily or regularly an emotional consciousness. Whether or not it is markedly affective in character depends upon the individual constitution of the observer.

(3) The belief-disbelief consciousness may be a straightforward experience, given, *e. g.*, in terms of a general kinæsthetic attitude, or of internal speech and localised kinæsthesis, or of the mutual relations of visual images; or it may be bound up with, incorporated in, a particular consciousness, verbal or visual. In the former case, the contents come to the observer as being, specifically, belief; in the latter case they come to him as the vehicle of belief, which itself finds conscious representation only in the course or mode of occurrence of the contents.

(4) Belief and disbelief are consciousnesses of the same kind.

(5) The certainty-uncertainty consciousness closely resembles that of belief-disbelief, but is in general more strongly affective. Certainty is pleasant; uncertainty, doubt, is unpleasant.

(6) We have supplemented the *Ausfragemethode* in two ways: first, by asking the observers, on the conclusion of the principal experiments, themselves to suggest materials and method for the continued investigation of the belief-disbelief consciousness; and secondly by confronting the observers, at the conclusion of the whole work, with a summary digest of their introspective reports. The first of these supplements served only to confirm our previous conclusions, but it is fair to add that the limits of time forbade us to use it to its fullest extent. The second gave valuable testimony to the correctness of the interpretation put upon the introspections by the experimenter.

Appendix

It is clear that the above conclusions hold, primarily, only under the conditions of our experiments. It is therefore important that the reader should know what sort of stimulus-material we employed. We had at first intended to print the sentence or mathematical expression at the head of every piece of quoted introspection. But we found that this procedure would extend our study to an unprintable length. As we did not wish to curtail the introspective evidence—already given only in sample—we were obliged to omit the stimuli; and we now must content ourselves with giving, in this Appendix, a few instances of the sentences, etc., employed.

Single Exposures. Since the whole world, as it exists for an individual consciousness, whether from a practical, theoretical, or æsthetical point of view, has come so to exist through prior mental process, it may be said that there is no objective fact which is not capable of being utilised by the psychologist.

We may say that the elementary or root-function in feeling is susceptibility to pleasure and pain.

Blessed are the meek, for they shall inherit the earth. Blessed are they which do hunger and thirst after righteousness, for they shall be filled. Blessed are the merciful, for they shall obtain mercy. Blessed are the pure in heart, for they shall see God.

The earthquake in Italy caused the death of 200,000 persons.

Wundt published the first edition of his *Physiologische Psychologie* in 1876.

In general, negroes have less power of grasping and exerting pressure than white men; intelligent persons have more power than persons of low intelligence.

The influence of women in all social matters is very great; our present civilisation may be traced to the contributions of women.

That the creature knows its proper food, and may be determined in its knowledge of it by previous impressions, is regarded as the first and primal indication of the presence of mental life.

Education is, in the last resort, a sort of hypnotism.

A hawk in South America could tell the time; it went every day to the monastery at the precise hour when food was distributed to the poor.

There have been many reformers, but none more radical than Rousseau; for he advocated the overthrow of civilisation and the return to a state of nature.

In truth, it was not language that generated the intellect; it is the intellect that formerly invented language; and even now the newborn child brings with him into the world far more intellect than talent for language.

Moral instruction should touch the hearts of the pupils.

Though we may by a device of abstraction distinguish between a mental process and its results, a producing operation and its product, we must remember that these are only two aspects of the same phenomenon.

In the heat of battle a man may be wounded and, for a time, be wholly insensible of his pain, because the intense engagement of the system—both brain and muscles—precludes the diffusion of impulses in the usual channels.

Urteile sind Bewusstseinsvorgänge auf welche die Prädikate richtig oder falsch eine sinngemässe Anwendung finden.

Coeducation is one of the best means for elevating the character of our boys and girls.

A can do a piece of work in 5 days, *B* can do it in 4 days. How long will it take *A* and *B* to do the work together? Answer: 2 2-9 days.

$$897+789+987=2673$$

$$\frac{42a^3-30a^2x}{35ax^2-25x^3}=\frac{6a^2}{5x^2}$$

Paired exposures. (*a*) Man is the creator of God. (*b*) Living men can communicate with the spirits of the dead.

(*a*) Even the purest well-water contains eleven million bacteria to the cubic inch. (*b*) The people on Mercury are trying to attract our attention by intense light-signals.

(*a*) Within fifty years we shall see the establishment of a democratic form of government in Russia. (*b*) Newton saw the law of gravitation in the fall of an apple.

(*a*) Parallel lines, however far produced, never meet. (*b*) Judgment is only a train of fluctuating ideas ending in a clear and steady idea.

(*a*) Our capacity of memory is determined by the number of cells

in our cerebrum. (*b*) Too great freedom of marriage means too great ease of divorce.

(*a*) Clear ideas are not necessarily persistent ideas. (*b*) There is no inborn difference between the different races; the existing differences are due to social heredity.

(*a*) Take alcohol out of human life, and the number of criminals will be greatly decreased. (*b*) Children love their parents for the pleasure they provide for them.

(*a*) There are but few cases in which desire is not accompanied by pain. (*b*) Examine the desires in your mind at this present moment, and you will find little else than pleasure.

(*a*) If there were no attraction between the earth and the sun, the mechanical pressure of light, thrown upon the whole surface of the earth, would drive it away with enormous rapidity. (*b*) Light is the vibration of the omnipresent ether.

(*a*) Corsets that embrace the waist with a grip that tightens respiration into pain, and skirts that weight the hip with heavier than maternal burdens, cause grievous maladies. (*b*) Clever children delight in acquiring knowledge, and feel pride in outstripping their competitors; but they must be restrained in their activity, more especially as it too often happens that mental precocity is associated with feeble bodily powers.

A PRELIMINARY INTROSPECTIVE STUDY OF THE ASSOCIATION-REACTION CONSCIOUSNESS.

By L. R. Geissler

The following report appears in advance of a more exhaustive introspective analysis of the "complex," begun by Miss E. T. Burr and the present writer in the Psychological Laboratory of Cornell University during the Summer Session of 1910. This study is to be continued during the present year. The experiments were conducted by Miss Burr; and the author, whose introspections are here reported, was one of the four principal observers. The material consisted of pairs of pictures or stories, presented to the observer at the beginning of the hour so that he could choose the one member of the pair without the experimenter's knowing which had been selected. The reaction-time was taken by a stopwatch, registering fifths of seconds. After every association the observer gave a detailed description of his state of mind and its contents, from the "ready-signal" until he had given his association-word. He was also asked to adhere as closely as possible to the temporal sequence of his experiences, and to notice in particular the background processes.

The introspections of *G* seem to be significant for three special points. (1) They indicate the general frame of mind during an association-reaction experiment. (2) They show that some of the mental processes occurring in *G*'s reactions are entirely indifferent to the presence or absence of a "complex." And (3) they furnish a clue to the nature and symptoms of certain kinds of "complexes."

The ideational type of *G* is predominantly verbal-motor. He is so largely dependent upon his general bodily attitude that he is not in the right mood toward the experiment, that is, in the attitude of passive, impartial indifference, until he has assumed the exact position in the chair which he happened to take at the beginning of the hour. His mental attitude at the moment of the "ready-signal" was as a rule one of calm, expectant attention, and indifference to extraneous stimuli; in the background was a vague sense of being "on guard." No further details of this state can as yet be given. Most of the insignificant stimulus-words made no material change in this state. The focus of attention shifted quickly

from the perception of the stimulus to the pronunciation of the reaction-word. The latter frequently appeared with reflex-like regularity; 45 out of *G*'s 91 irrelevant reactions took less than 1.5 sec., with an average of 1.2 sec. and a m. v. of .1 sec. In all these cases the general pattern of consciousness was that of a sharp focus and a very vague background. A few times only a sort of "blank" was experienced, as it is described, for example, in the following record: "verbally repeated stimulus-word ('East-Side') to myself, then short, empty pause, empty staring, fixation of objects opposite me, but nothing clear in mind for short moment, muscular sensations from movement of eyes in easterly direction, and reaction-word 'New York' came immediately" (time, 2.4 sec.). The reaction-times for the "blank" experiences average about 2 sec. Sometimes expectation is so intense as to anticipate a stimulus-word before it is completely heard; *e. g.*, "crisis" was expected to be "Christ," and "charity" to be "chariot." In such cases the expected word is usually given as the observer's reaction.

While with the insignificant words a great uniformity of the attentive state of mind thus prevailed, in the case of significant stimuli, the conditions were extremely labile. Here the observer was often unable exactly to describe his attitude; he "felt lost," or was "in a state of suspense," or he "had no memory or recognition of the stimulus-word until a reaction word occurred to him." Several times *G* had prepared himself for certain "dangerous" words by thinking beforehand of a "safe" reaction. But at the proper time this preparation failed to work, because some other mental process, perhaps an image or a strong feeling, successfully interfered with or delayed the prearranged reaction. Quite frequently the stimulus-word was repeated, more and more automatically, so that it gradually dropped out of the focus into the background, while nothing else took its place. The consequence was a "blank," which may have lasted sometimes as long as a second. The recovery was very sudden; a new idea appeared and led to an almost explosive reaction. It is difficult to describe this state more fully without mentioning its contents, which will be done in the third section. As the experiments were never continued for more than 50 minutes, *G* never experienced any signs of fatigue.

As regards the mental processes which are indifferent to the presence of a "complex," it has already been pointed out that *G* was, as a rule, entirely oblivious to his surroundings. Only in 8 of the insignificant and in 3 of the significant cases did environmental stimuli, such as visual objects or sounds, influence him by suggesting reaction-words. As *G*

is a very poor visualizer, the frequency of his visual images in these experiments seems remarkable. They were, of course never more than vague, except in two significant reactions, where he had seen some striking picture that had made a deep impression upon his mind. Most of his visual images were of a symbolic character; *e. g.*, a whole orchestra was represented by "a black spot with white specks in it," indicating the men in dress-suits and the white front of their shirts. Verbal ideas were by far the most numerous, ranging in degree from actual speech-movements to what *G* calls his "verbalizing tendency," in which sometimes a mere upward pressure of the tongue against the roof of the mouth indicates the beginning of a word or letter. In many cases the stimulus-word is simply supplemented to form a new (reaction-)word; *e. g.*, "beauty" is completed by "ful" to stand for "beautiful." No less frequent are alliterations and synonyms, while rhymes and even nonsense-rhymes occur at times. These verbal processes are distributed over insignificant and significant cases with relatively equal frequency. Closely related to *G*'s verbal ideas are the kinæsthetic elements of his consciousness. He frequently experienced strains indicating "a rigidity of the mouth and other speech-organs." Sometimes the mere "initial movement to close lips" leads to pronouncing a reaction-word beginning with *b* or *p*, such as "picture" or "boy." *G* often speaks of "a tendency to move," "to turn head," "to say something," or the like. In one case he had successively "several tendencies to move lips, but no anticipation of what was to come out," and in another case he made "several tentative lip and eye-movements." The latter are especially important for his whole mental make-up, as they frequently carry or represent to him the logical meaning of an idea. The symbolic character of the eye-strains and movements is, *e. g.*, brought out in the following introspections: "I had eye-movements toward place on page where stimulus-word is found," or: "on my lips definitely the word 'sesame' (stimulus was "open"), was inhibited, then word "door" with reference to China, looking sideways to left, like studying map of whole world where China is on left side." (This map had been used in my high school course.) In a good many cases *G* could not indicate the psychological processes underlying his thoughts, meanings, and references. Several reasons for this fact may be inferred from his introspections. Sometimes the thoughts were too fleeting or too vague; *e. g.*, "the thought came like a flash: that is good, safe," meaning of course that the reaction-word would not betray him. Or, sometimes, too many ideas occurred at once; "lots of things crossed my mind; . . . ideas are

there in some sort of vague awareness only." Again, the thoughts may form a chain of syllogisms, the final conclusion alone being present in a more concrete form. Usually the thoughts were interfered with by a strong emotional coloring, as in the following case: Stimulus: Spanish, Reaction: American, time: 1.9 sec. "I vaguely thought of Spanish-American war, mostly verbal, with thought of Cuba, a reference which seemed emotional, I had taken sides with the Spaniards." Quite frequently the reaction-word is accompanied in the background of consciousness by a thought of its justification, which is probably the result of the *Aufgabe* "not to betray myself." This *Aufgabe* acts, of course, like a determining tendency; it was not often conscious. Even when it was experienced, it was not always present in the same form or to the same degree. For example, the stimulus-word "reddish," referring to the hair of a girl in a story, led to the reaction of "rabbit," after 3.5 sec., through the following process: "association is due to thought that rabbit is spelt with 2 b's just as reddish has 2 d's, mostly verbal. After long, unpleasant inhibition of speech-organs, rigidity of lips and mouth,frowning and squinting, 'rabbit' came with thought: 'what is the difference? No need of sensible word.' This reasoning occurred while and after saying the word 'rabbit.'" It is worth notice that the "tendency to say something quickly" was stronger in the significant cases, while "a determination to say something sensible" prevailed with irrelevant stimuli. But this is not a frequent or a very consistent phenomenon. The perseverative tendency exerted its influence rather more frequently. Words that had occurred previously in introspections, or as stimuli, or as associations,were employed once or twice again during the same hour, usually with the recognition that they had been used before. The main reason why all these various different mental processes are grouped together is that they seem to have no special significance for the hidden complex, as they occur at least just as frequently, and often more so, with insignificant as with significant association reactions.

On the other hand, the mental processes which are apt to be connected with a "complex" appear only very rarely with indifferent words. It is much more difficult to make a sharp analysis of these symptoms and to enumerate separate processes, because as a rule the complex is felt merely as a general mental and physiological inhibition. The former is experienced as a "blank" or interruption of the regular course of mental life, as an obstacle or block in the stream of consciousness. *G* pictures it to himself in cross-section like the dry passage which the Israelites used to cross the Red Sea.

He finds three stages in the mental aspect of inhibition. Immediately upon hearing the significant word, consciousness is crowded with ideas in the focus and swamped by a strong affection. This stage passes more or less gradually into an empty staring, waiting, seeking, with practically no focus and all background. Finally a single idea comes, shooting to a head, that is, to focal clearness and discharging itself into movements of speech. It thus overcomes the inhibition or brings about its *Auflösung*, and initiates a state of bodily relief accompanied by a sudden change from the previous strong unpleasantness to a less strong pleasantness. These three stages seem to occupy various lengths of time and reach different degrees of intensity. The physiological side of inhibition includes such phenomena as holding of the breath, upward pressure of the diaphragm, drawing inward of the abdominal region, and rigidity of the laryngeal organs, tongue-tightness, and open mouth. The strains and pressures coming from these different parts of the body make up a large part of the background that is left during the second stage, the "empty staring and waiting period," during which one feels utterly helpless.

The feelings or emotions which in *G* characterize the presence of a "complex" are of two kinds, excitement and anxiety on the one hand, and relief on the other. The excitement seems to be mainly a quick, flash-like, but strongly unpleasant complex of faint visceral sensations, while the anxiety takes a certain time to develop, gradually becoming more and more unpleasant and at the same time confining itself more and more to the sensations due to muscular rigidity. There does not seem to be any regularity in *G*'s records about the occurrence of the one or the other emotion. Both emotions are subject to decay after several recurrences in the same hour. The visceral complex loses in intensity and excitement gradually wears off; and similarly, anxiety slowly disappears with the shortening of the empty waiting period. The change from excitement or anxiety to relief sets in with the appearance of a new idea. Relief is characterized, according to *G*'s observations, by the resumption of normal breathing, beginning usually with a long exhalation which leads sometimes to a whispered "oh!" and by the return of the muscles from the strained contraction to a normal equilibrium. This loosens the vocal organs and makes the pronunciation of the reaction-word possible. The speaking and hearing of the voice is moderately pleasant. In a few rare instances a "slight feeling of relief at easy reaction" is experienced, even in cases of insignificant stimuli, while there is no preceding excitement or anxiety.

These emotions are not the only symptoms of a complex. Quite frequently there are also references to the picture seen or the story read. Some of them consist of images, movements, or kinæsthetic sensations connected with the study of the picture or story, and may occur with varying degrees of completeness and vagueness. The other kind of references to the complex is more puzzling. They read like the following: "memory of end of story," or: "conscious of story," again: "aware that my association was taken from story," "the whole story was present, can't tell how," or this: "I knew stimulus-word had nothing to do with picture." The last quotation shows that some of these references appeared even when the stimulus was not intended to be significant. Probably these hints of the complex are signs of the general attitude of "being on guard," and should be grouped with the frequent attempts at justification of the given reaction-word. It may be mentioned that *G* did not always successfully maintain this attitude, but such cases are too rare to deserve fuller treatment.

What, then, is the "complex?" According to these results it is a strongly unpleasant group of ideas (connected with the concealed object), reinforced by certain organic sensations, and characterized by a quick change from focal crowdedness through a momentary blankness to the dominance of a single focal idea. It may, perhaps, be surprising to some readers that nothing has been said about any of the specifically Freudian complexes, such as the wish-complex, the sexual-complex, or the father-complex. Probably the conditions of these experiments were not favorable for their occurrence; the author cannot deny their existence in his dream life. It is hoped that future work will throw more light upon these problems.

A BIBLIOGRAPHY OF THE SCIENTIFIC WRITINGS OF WILHELM WUNDT

By E. B. TITCHENER and L. R. GEISSLER

(*Second supplementary list*)

The following is the second supplement to our Wundtian bibliography (this *Journal*, xix., 1908, 541; xx., 1909, 570). Information regarding the early titles was kindly transmitted to us, on Professor Wundt's behalf, by Professor Wirth of Leipzig; we have also to thank Dr. Okabe, of Cornell University, for verifying references.

Three popular articles—Ueber den Blick; Ueber die Mimik des Menschen; Ueber die Zeit—were published by Professor Wundt, about the years 1857-1860, in Karl Gutzkow's Unterhaltungen am häuslichen Herd (Leipzig, Brockhaus). We have not found this periodical in America, and we shall be grateful for any assistance that readers of the *Journal* may be able to render us in the matter.

1853

(1) *Ueber den Kochsalzgehalt des Harns.* Erdmann und Werther's Journal für praktische Chemie, lix. (Jahrgang 1853, zweiter Band), Heft 5 und 6, 354-359.

1855

(1) *Versuche über den Einfluss der Durchschneidung der Lungenmagennerven auf die Respirationsorgane.* Müller's Archiv für Anatomie, Physiologie und wissenschaftliche Medicin. Jahrgang 1855, 269-313.

1856

(1) [Add:] Druck von G. Mohr. pp. 28. Mit einer Steindrucktafel.

1857

(3) *Ueber den Einfluss hydrotherapeutischer Einwicklungen auf den Stoffwechsel.* Vogel, Nasse und Beneke's Archiv des Vereins für gemeinschaftliche Arbeiten zur Forderung der wissenschaftlichen Heilkunde, iii., 35-43.

1861

(6) *Ueber die persönliche Differenz zwischen Gesichts- und Gehörsbeobachtungen mit Rücksicht auf die astronomischen Durchgangsbeobachtungen.* Tageblatt der Naturforscherversammlung in Speyer, 17 Sept., 1861. Astronomische Section.

1866

(3) *Ueber Haeckels generelle Morphologie der Organismen.* Goeschen's Kritische Blätter für wissenschaftliche und praktische Medizin, 1866, nos. 2 and 3.

1887

(7) *Zum "ethischen Evolutionismus." Eine Entgegnung* [against H. Sommer]. Preussische Jahrbücher, ed. H. von Treitschke and H. Delbrück, lix., Jan.-June 1887, 5tes Heft, 478-485.

1908

(6) *Märchen, Sage und Legende als Entwicklungsformen des Mythus.* Dieterich's Archiv für Religionswissenschaft, xi., 200-222.

1909

(7) *Einleitung in die Philosophie.* Fünfte Auflage. Mit einem Anhang, etc. Large 8vo. Leipzig, W. Engelmann. pp. xviii., 471.

1910

(1) *Grundzüge der physiologischen Psychologie.* Sechste, umgearbeitete Auflage. Vol. ii., with 167 illustrations and indices. Large 8vo. Leipzig, W. Engelmann. pp. viii., 782.

(2) *Das Institut für experimentelle Psychologie zu Leipzig.* With one illustration. Psychologische Studien, v., Heft 5 und 6, 22 Februar 1910, 279-293. Reprint of 1909 (6).

(3) *Logik und Psychologie.* Zeitschrift für pädagogische Psychologie, Pathologie und Hygiene, xi., Heft 1, 1910, 1-18.

(4) *Die Prinzipien der mechanischen Naturlehre. Ein Kapitel aus einer Philosophie der Naturwissenschaften.* Zweite, umgearbeitete Auflage der Schrift: *Die physikalischen Axiome und ihre Beziehung zum Kausalprinzip.* Large 8vo. Stüttgart, F. Enke. pp. xii., 217.

William James

The death of William James has taken from American psychology its most distinguished representative, and from American psychologists the colleague held in highest and most affectionate regard.

Professor James' productive period as a writer of books was late in beginning. His first extensive work, the "Principles of Psychology" (1890), was not published till its author was forty-eight years old. After it came, in the remaining twenty years of his life, his "Text-book of Psychology" in 1892, "The Will to Believe" in 1897, "Talks to Teachers on Psychology" in 1898, "Human Immortality" in 1899, "The Varieties of Religious Experience" in 1902, "Pragmatism" in 1907, "A Pluralistic Universe" in 1908, and "The Meaning of Truth" in 1909. His honors, following on his works, came likewise late, but included degrees from Padua, Edinburgh, Oxford, Durham and Geneva abroad, and from Princeton and Harvard in this country. He was Lowell Institute lecturer in Boston, Gifford lecturer at the University of Edinburgh, and Hibbert lecturer at Oxford. He was a corresponding member of learned societies in France, Germany, Denmark, Italy and Great Britain, and was a member of our own National Academy of Sciences.

Abundant honors and abundantly deserved! And yet, to many American psychologists, the loss to their science and to philosophy will be overshadowed by their feeling of personal loss. Beyond the immediate circle of his colleagues and pupils at Harvard, many were happy in his friendship, and to many of the younger workers, in particular, he had given never-to-be-forgotten words of encouragement. No American psychologist has ever been held in like esteem, and none has carried through criticism and controversy such universal and affectionate regard. This was the natural tribute paid to powers of the highest order, exercised unselfishly; to a chivalrous passion for fair play, which often placed Professor James on the less popular side of disputed questions; and to a courtesy that assumed, in every opponent, standards and ideals equal to his own.

James, the psychologist, will long be held in high repute. Yet a growing science leaves even its ablest representatives behind; and despite the originality of his thought, the erudition that he so lightly carried, his consummate skill in inner observation, and his literary charm, the work that he has bequeathed to us will presently be superseded. But be that as it may,—the modest sincerity of the man, his human friendliness, and his crusading spirit were of the best that the world affords, and can never be outgrown. The EDITORS.

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